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Sport Fishery Abstracts

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Sport Fishery Abstracts

An abstracting service for fishery research and management

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Sport Fishery Abstracts is intended to furnish fishery biologists in government agencies and educational institutions with abstracts of the current literature in sport fishery research and management. Abstracts of papers on limnology, ecology, natural history and other fields of specialization will be included when the subject has application to the conservation of sport fish and the restoration of sport fishing.

The symbol (A) following an abstract indicates an author's abstract. Other initials following the abstract are those of abstractors whose names are listed on the last page. If no symbol is given the abstract was prepared by the Editorial staff. The abstracts are numbered serially through the four numbers of each volume. The numbers will be issued irregularly, with a limit of four per year. Each number contains separate Author and Subject indexes.

The first number of each volume contains a list of publications regularly reviewed for suitable abstracts. The succeeding numbers contain any additional publications covered. Suggestions for additional material are solicited in order to obtain as wide a coverage as possible.

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Prepared in the Branch of Federal Aid
Robert M. Rutherford, Chief
William C. Beckman*, Editor

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Additional Publications Reviewed For Abstracts

Biometrics

Outdoor Illinois

Tulane University Studies in Zoology

Bulletin, Scripps Institute of Oceanography

Biological Bulletin

161. Black, Edgar C., F. E. J. Fry and Virginia S. Black. 1954. THE INFLUENCE OF CARBON DIOXIDE ON THE UTILIZATION OF OXYGEN BY SOME FRESH-WATER FISH. Can. J. of Zoology, Vol. 32, No. 6, Dec., pp. 408-420.

The influence of carbon dioxide on the utilization of oxygen by 16 species of fresh-water fish from Algonquin Park, Ontario, Canada, has been measured by sealing fish individually in bottles containing water adequate in oxygen and with various concentrations of carbon dioxide. At death the ambient respired water was analyzed for free carbon dioxide and oxygen. Results give specific curves, which show that the oxygen in the respired water at the time of death was higher when the tension of carbon dioxide was increased. When the tension of carbon dioxide was low, the oxygen left in the water ranged from a tension of 4 mm. Hg for the northern brown bullhead, Ameiurus nebulosus, to 19 mm Hg for the common brook trout, Salvelinus fontinalis. Carbon dioxide tensions causing death when a tension of 160 mm. Hg of oxygen remained in the respired water ranged from 80 mm. Hg for the northern blacknose shiner, Notropis heterolepis heterolepis, to 338 mm. Hg for the northern brown bullhead. (A)

162. Arata, George F., Jr. 1954. A CONTRIBUTION TO THE LIFE HISTORY OF THE SWORDFISH, XIPHIAS GLADIUS LINNAEUS, FROM THE SOUTH ATLANTIC COAST OF THE UNITED STATES AND THE GULF OF MEXICO. Contribution No. 128 of the Marine Lab., Univ. of Miami, 60 pgs.

Thirty-three postlarval specimens of swordfish, Xiphias gladius Linn., from the South Atlantic coast of the United States and Gulf of Mexico, ranging in standard length from 6.1 mm to 192.1 mm are discussed. Nine specimens are illustrated and fourteen detailed descriptions are given, bringing together developmental characters for the range presented. Ten adults from Cuba and four from Canada are used to establish characteristic adult body proportions. The range of adult fish is given and the occurrence of females with varying stages of ovaries is mentioned. A hypothesis on the spawning time and area for the region concerned is given as taking place from the lower Caribbean to the South Carolina coast, probably year round, with the height of the season in Florida and Georgia waters from April through September. The stomach contents of 27 larval specimens are analyzed, and temperature, salinity and oxygen concentrations are given for stations occupied along the approximate axis of the Gulf Stream. (A)

163. Miller, L. F. and C. J. Chance. 1954. FISHING IN THE TAILWATERS OF T. V. A. DAMS. Progressive Fish-Culturist, Vol. 16, No. 1, Jan., pp. 3-9.

The TVA Reservoir System provides three general types of fish habitat: storage reservoirs, mainstream reservoirs, and the tailwaters below dams. Although all three types provide an abundance of fishing, none is more popular, more heavily fished, or yields more fish per trip than the tailwaters on the main Tennessee River. Tailwater fishermen account for approximately 52 percent of the 7-million-pound harvest from the entire TVA system.

Except for a slight decline in total fishing trips in 1951, tailwater fishing trends have been upward, showing an all-time high of 810,333 for fiscal year 1953. This is more than double the 1947 estimate of 339,000.

Beginning in 1950, heaviest angling pressure shifted from Guntersville Dam tailwater in Alabama to Kentucky Dam tailwater in Kentucky.

Angling from the bank predominates over angling by boat at seven of the nine mainstream tailwaters. At Wilson and Wheeler Dams the reverse is true because of general inaccessibility.

Commercial fishing immediately below dams is generally prohibited, or at least restricted by State law. The overwhelming importance of the sport fishing in our present economy appears to justify such action.

Although the various States impose no closed season on TVA mainstream reservoirs, there is no evidence of over-harvesting. During the past 8 years, 14,486 fish have been tagged on Wheeler and Guntersville reservoirs. Through February 1953, only 313 tags (2.2 percent) have been returned or reported.

164. Wood, E. M., P. J. Griffin and S. F. Snieszko. 1954. SYNTHETIC BINDING OF TROUT DIETS. Progressive Fish-Culturist, Vol. 16, No.1, Jan., pp. 19-24.

Carboxymethylcellulose, CMC, appears far superior to fresh beef spleen and salt as a binding agent for experimental trout diets. It allows easy diet preparation and is economical, physiologically inert, and effective at very low levels.

A method for measuring the degree of bind of a diet and for equalizing the degree of bind between experimental diets is described.

Three algin products have been tested for binding action. These materials are less efficient than CMC and are not physiologically inert, but they are more efficient than fresh beef spleen and salt. (A)

165. Al-Hamid, Mahmoud Ibrahim. 1954. THE USE OF DYES FOR MARKING FISH. Progressive Fish-Culturist, Vol. 16, No. 1, Jan., pp. 25-29.

Dyes were injected into the caudal fin, the dorsal fin, and the cheek of the fish by means of 1-cc. tuberculin syringe and a No. 27 hypodermic needle. The amount injected varied with the size of the fish and ranged from 0.1 cc. to 0.2 cc.

Brilliant vital red, Congo red, Alizarin red S, chlorazol fast pink B, migrosine, and trypan blue were nonlethal during the periods of the various tests. All marks made with these dyes were plainly visible at the last observation of each fish. These dyes were successful when used alone or in combination on individual fish. Fast green was also nonlethal, but marks faded after about a month. Trypan red, safranin O, and gentian violet were lethal at the concentration of 1 percent and dosages of 0.1 cc to 0.2 cc. The lethal effect was the same with 0.5 percent of gentian violet. Indigo carmine was

nonlethal, but the color failed to remain visible in the tissues as long as 5 days.

Alizarin red S, brilliant vital red, Congo red, trypan blue, chlorazol fast pink B, and nigrosine showed promise for use in marking fish. The tendency of fast green marks to fade suggests that this dye should not be used without further experimentation.

The marks in the caudal fin were more conspicuous than those in the dorsal fin and the cheek, also more easily recognizable when the fish swam in the aquaria or in the pond. When these marks are used, handling is unnecessary.

The results obtained from marking fish in aquaria and in a pond indicate that this technique can be applied as a management tool to the study of fish populations in ponds, streams, and lakes. It should be especially valuable in marking fish that are too small to carry a tag without bad effects.

166. Eustis, A. B. and R. H. Hillen. 1954. STREAM SEDIMENT REMOVAL BY CONTROLLED RESERVOIR RELEASES. Progressive Fish-Culturist, Vol. 16, No. 1, Jan., pp. 30-35.

Granby Dam, a feature of the U. S. Bureau of Reclamation's Colorado-Big Thompson project, is located on the Colorado River about 6 miles northeast of Granby, Colorado. Prior to closure of the dam in September 1949, and to a smaller degree thereafter, a large quantity of sediment was introduced into the Colorado River. This resulted from construction activity both above and below the dam site.

This paper relates the difficulties encountered in clearing the area in the river of sediment and how it was eventually accomplished by flushing.

167. Wagner, Edward D. 1954. THE EFFECTS OF ANTIBIOTICS AND ARSANILIC ACID ON THE GROWTH OF RAINBOW TROUT FINGERLINGS. Progressive Fish-Culturist, Vol. 16, No. 1, Jan., pp. 36-38.

The experiment was conducted to determine the effects of a low concentration of several antibiotics and arsanilic acid on trout. The tests were repeated at the conclusion of the initial experiment with approximately the same results obtained. Experimental fish used were rainbow trout hatched in experimental troughs in the laboratories at Loma Linda. The antibiotics used were: Aureomycin, Terramycin, Penicillin, and Chloromycetin.

None of the groups fed antibiotics or arsanilic acid showed so rapid an increase in weight as the control group. The fish fed penicillin and aureomycin actually lost weight during the first 2 weeks. Recovery was good in the group fed penicillin but poor for those fed aureomycin. All others were grouped fairly close together in the rate of gain per fish for the duration of the tests.

From these preliminary data it may be concluded that the antibiotics and arsanilic acid tested do not show a growth stimulation in fingerling rainbow trout when they are fed a low concentration in a good basal diet for a period of 6 weeks. The evidence indicates instead a slight or marked growth inhibition response in the fish. Whether or not these supplements tested are beneficial or harmful to the fish in other respects, such as resistance to disease, was not determined.

168. Shuster, Carl N., Jr. 1954. A METHOD FOR RECORDING MEASUREMENTS OF CERTAIN MOLLUSCS, ARTHROPODS, AND FISHES. Progressive Fish-Culturist, Vol. 16, No. 1, Jan., pp. 39-40.

While conducting a survey of softshell clam (Mya arenaria) populations in the Sandy Hook Bay region of New Jersey during the summer of 1952, the writer modified a well-known method—a method commonly used to measure fish, by perforating celluloid, aluminum, or other material—to facilitate the measurement of these shellfish. The essential and distinctive feature of this modification was the enclosure of graph paper within a protective jacket of aluminum foil. This use of graph paper served the dual function of recording and measuring, as the graph paper was "built-in-ruler."

169. Hemphill, Jack E. 1954. TOXAPHENE AS A FISH TOXIN. Progressive Fish-Culturist, Vol. 16, No. 1, Jan., pp. 41-42.

In recent years fish kills occurred in many Arizona farm fishponds as a result of aerial dusting of agricultural crops with insecticides. Ponds near fields being dusted or near wind-drifted material had partial or total kills of fish. Young populations usually suffered most severely. Toxaphene, a chlorinated camphene, was the insecticide causing the mortality.

Because of these observations and the reports of fishery workers in other areas, it was decided to study toxaphene as a possible toxin for fish population control. Experiments showed that 1 part in 10 million produced a total kill on carp at 65° F. in 72 hours.

Toxaphene breaks down under alkaline conditions. Treated waters with a pH of 8.0 or higher have been replanted with desirable fish within 4 weeks. Results indicate that partial population controls may be achieved in large lakes at a cost as low as 5 cents per acre-foot of water treated.

When the same precautions for handling are observed, toxaphene is no more dangerous than other materials regularly used as herbicides. As toxaphene breaks into nontoxic substances at 190° F., there is apparently no danger in human consumption of fish so destroyed.

170. Holton, George D. and Carl R. Sullivan, Jr. 1954. WEST VIRGINIA'S ELECTRICAL FISH-COLLECTING METHODS. Progressive Fish-Culturist, Vol. 16, No. 1, Jan., pp. 10-18.

Electrical fish-collecting methods used in West Virginia are modifications of basic methods developed by earlier workers. The work described was performed between September 1952 and February 1953 in connection with a project which was set up to investigate the possibility of increasing smallmouth bass populations by either eliminating or reducing populations of less desirable species.

The main work was on the Lost River in West Virginia's eastern panhandle. Unusually low water conditions prevailed during the fall when the area was studied. The river's flow at this time was about 17 cubic feet per second. Although little water was going over the riffles, there were still many pools one-fourth mile or more long, up to 100 feet wide, and up to 10 feet deep. The average stream width was 54 feet. The bottom was predominantly rocky. Water temperatures were usually lower than 65° F.

Alternating current was used. Two A. C. units, one a 350-watt Onan generator; the other a 2,500-watt Leland generator were used. Both were speeded up to give voltages estimated to be between 180 and 200. No rheostats or transformers were used with the equipment described in this paper.

Two bare-wire electrodes were stretched across the stream, parallel to each other and 6 to 8 feet apart. They were kept close to the bottom and moved slowly upstream or downstream through the study area. This arrangement allowed full coverage of the stream width (up to 50 feet), while at the same time the electrodes remained within effective distance of each other. In sections where they could be used, these electrodes proved superior to the paddle-type. The electric field covered a much greater area, especially upstream and downstream, making it practically impossible for fish to "run" through and escape.

Flexible 12-gage copper wire was used for the parallel-wire electrodes. Wire made of a few (6) heavy strands proved far more durable than wire made of many fine strands. A wooden handle, 5 feet long, was attached to each end of each wire. Two 50-foot wires could be managed by two men, one at each bank, if the bottom was fairly free from obstruction. Two or three more men were needed to collect fish. The handles (with wires attached) were used as electric probes for collecting fish from undercut banks, roots, etc. Depths up to 7 feet were efficiently shocked by this method. It was not tried in deeper water.

For wide pools a modification of Funk's (1949) electric seine was used. The largest pool studied had widths up to 125 feet and depths to 10 feet. It was successfully shocked using the 2,500-watt Leland generator. The 350-watt Onan generator was inadequate.

Paddle-type electrodes were used in the stream sections where it was impractical to use either of the other two types described.

A mark-and-recovery system was used for making estimates of the fish population. The data show that over-all efficiency in recovering marked fish was good. Recoveries of 50 percent or better were recorded for 18 of 29 categories in which fish were marked. Only 2 categories showed efficiencies of less than 25 percent.

Certain species were more easily captured than others. For example, as a rule, efficiency in recapturing yellowbelly sunfish was lower than that for rock bass, and the efficiency for Centrarchids was lower than that for suckers. Also, large fish were generally more easily collected than small fish of the same species.

A 2,500-watt, 230-volt D. C. Homelite generator was obtained in November 1952. The parallel-wire electrodes were used in removing suckers from a study area 2.5 miles long on Mill Creek in Grant County. This apparatus proved very satisfactory. An estimated 90 percent by weight of the white and hog suckers (1,542 pounds total) was removed from the study area in two trips. On the first trip, 1,140 pounds of white and 295 pounds of hog suckers were removed; on the second trip (started 3 days after the first was completed), 73 and 34 pounds. Most fish were "attracted" to the positive wire, which was kept close to the surface. Fish would remain at this wire for 5 to 20 seconds, after which many of the fish would become stunned and settle to the bottom. Owing to this "attracting" phenomenon, direct current was judged to be more efficient than alternating current for collecting fish in quiet water. However, in fast water alternating current seemed better. The direct current did not have sufficient "attracting" power to prevent the fish from washing out of the electrical field. Once out, they would quickly recover, making their capture difficult. On the other hand, fish stunned with alternating current usually remained paralyzed for several minutes, even though washed out of the electrical field, and in clear shallow water were easily netted. The difficulty encountered with direct current in fast water was partially overcome by shocking downstream.

The tendency of fish to avoid capture after once being in the electric field was noted for both alternating current and direct current.

The data show that a smaller number of fish in most categories was taken on the third trip than on the second, yet more of each category were captured on the trip made the following morning than on the third trip the first day. Legal-size (total length 9 inches or over) smallmouth black bass were an exception. These data are interpreted as showing that fish seek cover after being once exposed to the electric current. Such an avoiding response was observed in all collections in which more than one trip with the shocker was made.

171. Fenderson, Carll N. 1954. THE BROWN TROUT IN MAINE. Maine Dept. of Inland Fisheries and Game Fishery Research and Mgt. Div. Bulletin No. 2, August 1954, 16 pgs.

The life history of the brown trout is presented. Brown trout are considered a poor investment in terms of return to the fishermen. They should not be introduced into lakes or streams capable of supporting native salmon or trout since they readily displace the native species.

The principal characters used to identify brown trout from landlocked salmon are vomerine teeth, shape of tail and color of adipose fin.

172. Phillips, Arthur M., Jr. and Donald R. Brockway. 1954. EFFECT OF STARVATION, WATER TEMPERATURE, AND SODIUM AMYTAL ON THE METABOLIC RATE OF BROOK TROUT. Progressive Fish-Culturist, Vol. 16, No. 2, April, pp. 65-68.

For several years it has been thought that the metabolic products of the trout are the limiting factors in the establishment of the carrying capacities of holding equipment. Previous experiments have shown that the removal of products of metabolism from the water is advantageous to the trout physiology. However, in the use of fish distribution units, it would be more practical to prevent the formation of these products of metabolism than to remove them after their formation. These experiments were conducted to determine the accumulation of ammonia and the utilization of oxygen by trout under the effects of cold water. Starvation, and the drug sodium amytal.

Trout were held in stainless steel aquaria (14 by 6 by 8 inches) which had been painted inside with black asphaltum paint. Sufficient aeration was secured by means of a perforated rubber hose which was run around the bottom of the aquarium. At intervals during a 12-hour period, the water in the aquaria was analyzed to determine the ammonia present (direct messlerization) and the oxygen remaining (Winkler). Two series of experiments were run.

Both cold water and the 63-hour period of starvation were effective in reducing the metabolic rate as measured by the accumulation of ammonia and the amount of oxygen remaining in the water. Of these two variables, cold water was the more effective. In fact, when the trout were starved for only 15 hours and then subjected to cold water (first series), the results were superior to those in the control of the second series (63 hours' starvation). The combination of cold water and 63 hours of starvation resulted in a still further reduction of the metabolic rate.

The drug sodium amytal was effective when it was used in combination with the longer period of starvation but had no effect when used with the shorter starvation period (15 hours). The action of the drug was delayed between 4 and 6 hours.

173. John, Kenneth R. 1954. A SPACED-DISC, SELF-CLEANING FISH SCREEN. Progressive Fish-Culturist, Vol. 16, No. 2, April, pp. 70-74.

This paper gives a description of a new fish screen designed for use in remote streams where personnel is not available for constant cleaning. Diagrams are included. Advantages of the design are that: The screen has no moving parts exposed to water. It has no openings or perforations that can engage a stick and stop the machinery. A stick could become lodged between two discs, but the screen would continue to rotate. The screen's width can easily be altered by adding or subtracting discs if the installation is planned to allow such changes. The screen can be wholly disassembled for transport, and, by changing the thickness of washers, can be modified to retain different sizes of fish.

174. Smith, Stanford H. 1954. METHOD OF PRODUCING PLASTIC IMPRESSIONS OF FISH SCALES WITHOUT USING HEAT. Progressive Fish-Culturist, Vol. 16, No. 2, April, pp. 75-78.

The widespread use of cellulose acetate impressions of fish scales for age and growth studies has led to the development of at least two satisfactory methods of making these impressions. One method employs an arbor press and sufficient heat to cause the plastic to flow. This results in what might be considered a mold or cast of the sculptured surface of the scale. A second method of making scale impressions in plastic involves the use of a roller press similar to that described by Arnold (1951). The purpose of this discussion is to elaborate on the use of the roller press in scale-impression work and to describe some of the refinements developed in the Ann Arbor, Michigan, Laboratory of the Great Lakes Fishery Investigations. These refinements have produced an impression which casts a projected image with features as fine and accurate as those from the scale itself and, in some instances, with less objectionable light refraction.

175. Cummins, Robert, Jr. 1954. MALACHITE GREEN OXALATE USED TO CONTROL FUNGUS ON YELLOW PIKEPERCH EGGS IN JAR HATCHERY OPERATIONS. Progressive Fish-Culturist, Vol. 16, No. 2, April, pp. 79-82.

At the State fish hatchery at Put-in-Bay, Ohio, fungus has long been a major problem, increasing the workload of hatchery personnel during the incubation period of yellow pikeperch (Stizostedion v. vitreum) eggs. This experiment was an attempt to control the fungus that gathers on the eggs—dead, unfertile, or living.

Repeated use (three applications) of malachite green oxalate on yellow pikeperch eggs appears to rid eggs of all visible fungus, apparently is not harmful to living eggs, causes obnoxious odors and makes it difficult to ascertain the percentage of hatch. One application of malachite green oxalate at an early stage (as soon as fungus appears) will retard but not prevent the growth of fungus.

176. Lawrence, J. M. 1954. CONTROL OF A BRANCHED ALGA, PITHOPHORA, IN FARM FISHPONDS. Progressive Fish-Culturist, Vol. 16, No. 2, April, pp. 83-86.

In the southeast, within the last 5 years, several hundred farm fishponds have become infested with a branched form of filamentous algae that is called Pithophora. It grows best during the warmer months. Once Pithophora has become established, it forms a heavy blanket of floating alga over much of the pond surface and thus renders a pond unfit for fishing. In experiments at Auburn this alga has reduced fish production by as much as 50 percent by competing with the phytoplankton for the plant nutrients during the summer growing period. Pithophora also tends to produce overcrowded bluegill populations by preventing adequate predation by bass.

The most satisfactory and economical control measure for Pithophora at present is to treat the entire pond with dehydroabietylamine acetate (trade name—Hercules Algicide D). At a concentration of 0.7 p.p.m., this material is toxic to bluegills,

goldfish, and young largemouth blackbass. Therefore, it would be wise to avoid treating a pond in a 4-week period after bass spawning, and to avoid treating pond areas where bream beds are located.

Tests indicate that the branched alga may be killed by a concentration of less than 0.5 p.p.m. of this acetate in the pond when the water temperature is above 70° F.

Three treatment procedures are described: spraying, dragging and float method.

At present, there are no available laboratory data regarding the toxicity of Hercules Algicide D to cattle, hogs, or sheep. However, in the summer of 1953 cows obtaining their only drinking water from ponds treated with this material apparently suffered no ill effects.

177. Moen, Tom and Muhrl Lindquist. 1954. THE NORTHERN PIKE HATCH AT THE CLEAR LAKE (IOWA) HATCHERY. Progressive Fish-Culturist, Vol. 16, No. 2, April, pp. 89-90.

For several years prior to 1953, the adult population of northern pike in Clear Lake (area, 3,643 acres; maximum depth, 20 feet) was very low. During the spring of 1951, a few adult northern pike were stocked in Ventura Marsh, a 630-acre marsh that drained into Clear Lake and was separated from the lake by a road grade. During the spawning run these adults were collected. Seine hauls and other observations late in summer indicated that there was a large number of fingerling northern pike in the marsh. Late in the fall of 1951, the stop logs of the control structure were removed and the northern pike were allowed to migrate to the lake. This procedure was repeated in 1952, when more than 5,000 northern pike fingerlings were recorded as they moved to the lake.

In spite of the questionable spawning ability of the small northern pike, it was decided to transfer 100 females and 200 males to the marsh, the remainder of the catch to be held in the combination carp-trap and water-control structure located on the marsh side of a bridge over the outlet of the marsh for later use in the hatchery.

In the hatchery the northern pike were checked each day by slight pressure on the abdomen. Only females from which eggs flowed freely were used. The first females were stripped on March 30 and the last on April 13. In this period 540 females produced 81 quarts of eggs. Eggs from these fish were of uniform size, but rather small for the northern pike, as they averaged 75,000 per liquid quart. Fifty-two percent of these northern pike eggs survived to the eyed or hatching stage, thus producing 3,165,000 fry. The average female produced approximately 11,000 eggs.

178. Palmer, David D., Roger E. Burrows, O. H. Robertson and H. William Newman. 1954. FURTHER STUDIES ON THE REACTIONS OF ADULT BLUEBACK SALMON TO INJECTED SALMON AND MAMMALIAN GONADOTROPHINS. Progressive Fish-Culturist, Vol. 16, No. 3, July, pp. 99-107.

During the summer and fall of 1952, a second experiment was conducted at the Salmon-Cultural Laboratory of the U. S. Fish and Wildlife Service at Entiat, Washington, to explore further the possibilities of hastening the maturation of adult blueback salmon (Oncorhynchus nerka) by injection with gonadotrophic substances.

The results of these experiments may be summarized as follows: (1) More than 60 percent of the adult salmon in all groups died because of high water temperatures. (2) Handling affected the loss in both of the experimental groups that received repeated injections. (3) There was a wide variance in the rate of maturation of the fish that received injections of salmon pituitary extract. This variance may have been due to the loss of varying amounts of injection fluid during and after injection. (4) Injection of salmon pituitary extract into adult salmon hastened markedly the development of spawning coloration and other secondary sex characteristics, ripened males as early as 3 days after injection, advanced slightly the spawning period for the females, and lowered the fertility of the eggs. (5) No antagonistic action attributable to sex differences in the injected hormones was demonstrated in this experiment. (6) Injection of mammalian gonadotrophin into adult salmon failed to hasten the development of spawning coloration or other secondary sex characteristics, made no measurable change in the time of maturation, and had no effect on the fertility of the eggs.

179. Ball, Robert C. and Edward H. Bacon. 1954. USE OF PITUITARY MATERIAL IN THE PROPAGATION OF MINNOWS. Progressive Fish-Culturist, Vol. 16, No. 3, July, pp. 108-113.

A serious shortage of bait minnows exists in Michigan and is becoming more critical as the number of anglers on lakes and streams increases.

To test the practicability of the use of pituitary hormones in the production of bait fish, laboratory and field experiments were planned and carried out during the spring and summer of 1950, using the facilities of Michigan State College and Wolf Lake State Fish Hatchery.

While carp pituitary glands were used in all experiments, no attempt to separate the lobes was made. Just before use, dried glands were pulverized in a mortar and mixed with distilled water; frozen glands were macerated to form a thick suspension in distilled water. No difference between the effects of frozen and dried pituitaries on fish was noted in any of the experiments.

After it had been demonstrated in the laboratory that the carp pituitary injections would induce release of eggs and milt, a large-scale trial was set up at Wolf Lake Hatchery.

Results of injections of pituitary gland material in these tests are summarized as follows: (1) Creek chubs can be stripped within 48 hours after injection if treatment time approximated normal spawning season. No stripping was possible without injection of pituitary hormone. (2) Viable eggs and normal fry can be obtained by this method approximately 6 weeks prior to normal spawning season. (3) Experiments with other species of fish, using carp, other fish pituitaries, and purified fractionations of mam-

malian pituitary, have shown contradictory results but enough promise to make further exploration along these lines desirable.

180. Miller, Lawrence F. 1954. SPRING FISHING ON TWO TVA MAINSTREAM RESERVOIRS, 1945-1953. Progressive Fish-Culturist, Vol. 16, No. 3, July, pp. 114-121.

A creel census was taken, beginning in mid-March and continuing through June, at three localities on two TVA mainstream reservoirs from 1945 through 1953. No creel census was taken in 1952 because of lack of funds. This work should be continued indefinitely to determine trends in the fish catch. So far, neither the creel census nor the tagging studies indicate that the catch by year-round fishing is excessive.

The TVA mainstream reservoirs are large, totaling about 448,000 acres in area. Fishing pressure still remains moderately light. In these reservoirs angling has little apparent influence on the relative abundance of fish of various species. Our harvesting equipment, the hook and line, is inefficient "machinery." Our lures must compete with natural food. It seems almost impossible to harvest, by hook and line fishing, so much of the crop that an inadequate broodstock remains.

181. Earp, B. J. and R. L. Schwab. 1954. AN INFESTATION OF LEECHES ON SALMON FRY AND EGGS. Progressive Fish-Culturist, Vol. 16, No. 3, July, pp. 122-124.

A heavy infestation of freshwater leeches (Piscicola salmositica) on eggs and fry of pink salmon recently occurred at the Hood Canal State Salmon Hatchery of the Washington State Department of Fisheries, located at Hoodsport, Washington. This station is supplied with both fresh and sea water, which can be delivered to the troughs and ponds in any desired combination.

As nearly as could be determined, little, if any, damage occurred to the eggs as a result of attachment by one or more leeches. Once attached to the fry, however, the leeches quickly became gorged with blood, and the fry so attacked invariably died. Large numbers of leeches, both gorged and ungorged, could be found throughout the fresh-water system.

None of the chemicals (formalin, roccal, pyridylmercuric acetate) commonly employed by the Department for the treatment and control of bacterial and parasitic diseases showed any effect on the leeches. It was found, however, that they were particularly sensitive to undiluted sea water having a salinity of at least 28 parts per thousand.

On contact with sea water, sac fry became subdued in movement; they regained normal activity as soon as they were returned to fresh water. Test lots were observed several days after exposure, and no undue mortalities developed except in fry that previously had leeches attached. All these fish died.

In addition to the pink salmon fry and eggs in the hatchery troughs, there were 3- to 4-inch silver salmon fingerlings weighing approximately 50 to the pound in outside rearing ponds. The water supply came from the same source as that used for the hatchery troughs. A random sample of these fish showed none with leeches attached. It is, therefore, believed that leeches offer no serious threat to the well-being of fish of this size. Release of these fish to salt water will certainly remove any leeches that may be attached.

182. Wales, J. H. 1954. RELATIVE SURVIVAL OF HATCHERY AND WILD TROUT. Progressive Fish-Culturist, Vol. 16, No. 3, July, pp. 125-127.

Several workers have shown that the survival of hatchery fingerlings in streams is lower than that of comparable wild fingerlings. The debilitating influence of hatchery life could be the cause of this. Certain tissues of hatchery-reared trout have been shown to be abnormal in comparison with the tissues of wild trout. The lack of exercise in the hatchery environment has also been cited as a possible cause of lowered vitality and consequent reduced survival. There is no evidence to indicate that hatchery life is not partially responsible for the relative lower survival. The author discusses the influence of the protection afforded hatchery-reared trout until they are released in the wild upon their chances of survival. Also, he points out the variance in the suitability of the fish to the particular water where planted.

183. Graham, Joseph J. 1954. THE ALEWIFE IN FRESHWATER. Progressive Fish-Culturist, Vol. 16, No. 3, July, pp. 128-130.

The alewife, Pomolobus pseudoharengus (Wilson), an essentially marine clupeid, is found in Lakes Ontario, Erie, Huron, and Michigan, in a few small lakes in the Province of Ontario, and in several lakes in the State of New York. This fish has been known to be well established in Lakes Seneca and Cayuga of New York State since 1868 (Smith 1892) and in Lake Ontario since 1883 (Pritchard 1929).

Many theories have been advanced to account for the presence of alewives in fresh water where they are not known definitely to have been introduced or to have invaded in recent years. Radforth (1944) has presented the most recent and acceptable theory for the presence of the alewife in Lake Ontario: "...because the invasion of the Champlain Sea is held responsible for the occurrence of other marine species such as the smelt and shad in certain eastern waters, it is not improbable that the presence of the alewife in Lake Ontario may also be attributed to the marine invasions."

The greatest obstacle to the success of the alewife in freshwater is found in its large annual mortality. Regardless of the mortality, the alewife is successful. Its ability to succeed lies in the following conditions: (1) Earlier sexual maturity in freshwater, (2) availability of spawning sites, (3) lack of upstream migration, (4) lack of commercial fishing pressure.

At present the alewife is spreading through the remainder of the Great Lakes.

184. Johnson, Malcolm C. 1954. PRELIMINARY EXPERIMENT ON FISH CULTURE IN BRACKISH-WATER PONDS. Progressive Fish-Culturist, Vol. 16, No. 3, July, pp. 131-133.

Brackish-water pond culture has been conducted on a commercial scale for generations in many Asiatic countries.

In July 1952, an experimental project in brackish-water pond culture was initiated at the Marineland Research Laboratory. The mullet was selected as the test animal in spite of its inherent handicaps as a commercial pond species.

Four 1/8-acre experimental ponds were excavated in the tidal marsh area adjacent to the Intracoastal Waterway at Marineland, Florida. At no time did the chemistry of the pond water appear unfavorable for most estuarine fish.

On December 31, 1952, each pond was stocked with 2,000 fingerling striped mullet per acre. The young mullet averaged 29.8 millimeters (total length) on this date.

Contamination of all ponds by species of fish other than the mullet occurred in spite of the precaution of placing two thicknesses of plastic window screen over each inlet pipe. These species included black drum, speckled trout, sheepshead, menhaden, killifish, and others. All are believed to have entered the ponds as larvae small enough to pass through the screens, as the ponds were treated with emulsifiable rotenone (3.0 parts per million) several weeks before being stocked. The screens were installed prior to the poisoning.

The unfertilized pond produced 154.4 pounds of fish per acre. The highest yield obtained by fertilization was 276.8 pounds per acre. The maximum increase due to fertilization was therefore 122.4 pounds per acre; the average increase was 81.4 pounds per acre. The maximum production of mullet was 128 pounds per acre, an increase of only 28.4 pounds due to fertilization. The average mortality of the mullet in all ponds was 42.6 percent. None of the fish produced approached a marketable size.

It was fully recognized that, owing to the small number of experimental units, the results of the experiment by no means represented true averages of the production of fertilized and unfertilized brackish water. The results were considered conclusive in showing that the addition of inorganic fertilizer would not, even under the most favorable conditions, increase the production of mullet or the other species involved enough to sustain a commercial pond fishery.

185. Dubets, Harry. 1954. FEEDING HABITS OF THE LARGEMOUTH BASS AS REVEALED BY A GASTROSCOPE. Progressive Fish-Culturist, Vol. 16, No. 3, July, pp. 134-136.

The fish for examination were taken by means of an electrical shocker using a generator that supplied 180-cycle 230-volt alternating current at 6.3 amperes. The electrodes were mounted on booms on the bow of a boat. In operation the boat was slowly propelled through the water by an outboard motor. At times the apparatus was operated along the shoreline and at times in a circle in open water. Any stunned bass that was more than 12 inches in length was dipped up. While holding the fish by its lower jaw, the examiner inserted a long metal cone—a gastroscope—of appropriate size into the bass' mouth, through the pharynx, and into the anterior end of the stomach. The funnel held the stomach open in such a manner that the major items of food in the stomach were easily discerned. A record was made of the stomach contents along with the length of the fish. A record was also made of such food fish as were in the stomach. The specimen was then released.

To observe the variation in percentage of empty stomachs as associated with time of day, the Crab Orchard population was sampled around the clock. Also from the Crab Orchard data, analyses were made of the size of shad eaten and the efficiency of collecting as associated with sampling by day and by night.

To reveal the effect of the presence of different forage-fish populations on the feeding habits of the bass, four lakes were sampled. In two of these lakes, the gizzard shad was abundant; in the other two, the shad was either absent or very scarce. For each lake the principal fishes are given, along with a discussion of the feeding habits of the bass.

The high percentage of empty stomachs occurring day and night indicates low vulnerability of the prey species. The fairly even distribution of full stomachs is rather surprising, because such a condition indicates that feeding is fairly well dispersed throughout the day and night. The high percentage of shad in the bass diet may indicate either greater relative availability, vulnerability, or palatability of this species. But regardless of which is indicated, the fact remains that, where present, the shad is heavily utilized by the largemouth bass.

186. Stockley, Clinton, 1954. NEW METHOD OF ARTIFICIALLY PLANTING SALMON EGGS. Progressive Fish-Culturist, Vol. 16, No. 3, July, pp. 137-138.

The problem of introducing salmon into watershed areas barren of the species has been mastered in most fishery organizations by means of hatcheries and fry or fingerling plants. The Alaska Department of Fisheries, in lieu of hatchery facilities and standard methods of transportation, has made extensive use of either newly fertilized eggs or eyed eggs for such introductions.

For maximum results the eggs must be placed in the gravel of selected stretches of stream bed. Minimum requirements, as in the case of natural redds, are adequate subsurface percolation of water, protection from freezing during winter low-flow periods, and protection from natural predators such as cottoids or trout.

Nests resembling natural salmon redds are dug in selected riffles of a stream to be planted. These excavations are roughly circular, about 3 to 4 feet in diameter, and 12 to 18 inches deep. All material removed is placed on the downstream edge to form a semicircular dike below the nest. A large stone slab is placed over the bottom of the nest and supported at the corners by stones 6 to 8 inches in diameter. Large stones are loosely placed about the margins of the slab, resulting in the formation of an enclosed "room" to be used as the incubator. Next

a 5-foot section of metal drainpipe is placed so that one end enters the "room" and the other angles upstream and a few inches above the surface of the water. The slab is then completely covered, first with coarse stones and last with fine gravel containing some sand.

After the nest is prepared, several gallons of water are poured down the tube to assure free passage and distribution of the eggs. Then the eggs are poured in water down the tube and flushed with water at intervals. Properly constructed nests will contain approximately 1 gallon of eggs. During hot weather the completed nests are treated with malachite green to retard the formation of fungus. The tube is then withdrawn, as the operation has been completed.

Observations made after 2 years of planting by this method indicate excellent survival of the eggs to fry and to fingerling stages.

187. Johnson, Leon D. 1954. USE OF URETHANE ANESTHESIA IN SPAWNING EASTERN BROOK TROUT. Progressive Fish-Culturist, Vol. 16, No. 4, October, pp. 182-183.

The use of urethane anesthesia to facilitate the handling of fish has been common practice in Wisconsin since the report by Gerking (1949). Urethane anesthesia has proved a reliable and convenient aid in removing fins of trout, yellow walleye, muskellunge, bass, and panfish. Preliminary experiments in 1949 showed promise for its use in spawning procedures, but the method was not developed further at that time.

During September 1953 an experiment was conducted at the Osceola hatchery to determine the value of urethane for the taking of spawn from eastern brook trout.

The spawn-takers, after orientation to the use of urethane for spawning trout, demonstrated an approximate 25-percent reduction in work time for the new method. Size of the trout made no difference in spawning time, for 1.5-pound adults were handled as quickly as 0.5-pound 2-year-old fish.

The percentage of egg hatch and broodstock survival were similar for groups handled with and without urethane anesthesia. A slightly higher egg hatch (93.2 percent, as compared to 92.5 percent) was recorded for anesthetized fish. Survival of female trout of comparable age, with and without urethane anesthesia, was 93.1 and 93.3 percent, respectively. Autopsies of trout over a 3-month period showed that all deaths could have been due to other causes, not to use of anesthesia.

Trout given urethane anesthesia daily were tolerant to it. The 5 selected trout survived an 18-minute immersion in 0.5-percent solution on 15 consecutive days with no mortality or undesirable symptoms. These trout were autopsied, and their internal organs appeared identical to those of trout that had not been subjected to the urethane, indicating that repeated use of it on males was not harmful.

188. Parsons, John W. and J. Bruce Kimsey. 1954. A REPORT ON THE MISSISSIPPI THREADFIN SHAD. Progressive Fish-Culturist, Vol. 16, No. 4, October, pp. 179-181.

The Mississippi threadfin shad, Signalosa petenensis atchafaylae Evermann and Kendall, has in recent years caused considerable speculation among fishery workers. Little has been published about the threadfin shad, and the authors feel that recent information on its status as a forage fish should be made available.

Several subspecies of threadfin shad are native to the gulf region from Florida to Texas, the lower Mississippi River drainage, and Mexican waters. The most northern of these subspecies, the Mississippi threadfin, is common in mainstream impoundments of the Tennessee River in Kentucky, Tennessee, Mississippi, and Alabama. However, no threadfin shad have been found in the Cumberland River, which drains much of eastern Kentucky and middle Tennessee and flows into the Ohio River 16 miles above the mouth of the Tennessee River.

Except for its smaller size, yellow fins, longer prominent dorsal ray, and more terminal mouth, the threadfin shad is similar in appearance to the gizzard shad. In the Tennessee River, threadfin shad are found only where the gizzard shad and the skipjack are also abundant. Therefore, the value of the threadfin shad as a forage fish has been difficult to determine.

Threadfin shad appear to be an ideal forage fish. They are short-lived—few reach 2 years of age—and seldom reach 7 inches in length. They are generally pelagic and often feed and migrate in schools numbering many thousands. In fall and spring they congregate in large numbers below the dams. Fishing for white bass, sauger, and crappie is especially good at such times.

The Mississippi threadfin shad suffer high mortality when exposed to low water temperatures or sudden changes in water temperature. Threadfin shad also showed high mortality when crowded.

When transported or held under confinement, threadfin shad are extremely active. Sodium amytal, a sedative used successfully in California to decrease the metabolism and oxygen demands of trout during transportation, did not appear to quiet the fish or increase their survival. There was some indication that survival was improved when transport containers rested on foam-rubber pads.

The experiments in Tennessee indicate that approximately 100 of the 5- to 6-inch threadfin shad can be transported in a 25-gallon container with no added sedative or oxygen. Temperatures should be held between 50° and 60° F. Maintaining a current of water in the tank appeared beneficial. The fish orientated themselves against the current and were less agitated than when held in regular containers without a current.

Research by biologists of the California Inland Fisheries Branch has indicated that lack of a suitable forage species is probably the greatest deterrent to warm-water fishing in that State's fluctuation reservoirs. Rapid drawdown frequently limits the spawning success of present forage species and virtually eliminates food production in the important littoral zone. It appears that since the threadfin shad is not dependent upon this unstable littoral zone at any time

during its life cycle, this fish may be an answer to the forage-fish problem in fluctuating reservoirs.

189. Lawrence, J. M. 1954. A NEW METHOD OF APPLYING INORGANIC FERTILIZER TO FARM FISHPONDS. Progressive Fish-Culturist, Vol. 16, No. 4, October, pp. 176-178.

Use of inorganic fertilizers to increase fish production in farm fishponds is now practiced by thousands of pondowners throughout the United States. The methods of applying the materials were originally described by Swingle and Smith (1939). They recommended that the fertilizer materials be broadcast from the bank over the shallow areas of small ponds, and that the materials be distributed over the shallow areas of larger ponds by the use of a boat and motor. These methods of application have produced good results but are time-consuming.

During the winter and early spring of 1953, experiments with nigrosine dye indicated that fertilization might be accomplished by using the water currents in ponds.

The idea of placing the dye in floats on the pond surface and allowing the material to distribute itself over the pond was tried. The experiments showed that the water currents, because of wind action in a pond, were sufficient to distribute the dye from one float uniformly, within a 24-hour period, throughout the surface waters in ponds 1 to 5 acres in size.

As such results were obtained with dye, it was reasoned that ponds could be fertilized by placing fertilizer on platforms under water and allowing the water currents to distribute it over the ponds. Five ponds, their sizes ranging from 1 to 26 acres, on the Farm Ponds Project at Auburn were fertilized by means of platforms during the spring and summer of 1953.

The platform method of applying fertilizer to a pond has several advantages over the previously recommended fertilization methods. First, the platform method is a much easier method of applying the fertilizer. Second, the fertilizer nutrients go into solution in the top waters of the pond and thus are more readily available to phytoplankton and less available to bottom growths of filamentous algae and rooted vegetation. Third, the nutrients go into solution over a longer period of time. Fourth, as the fertilizer elements go into solution in the top waters, there is less possibility that the phosphorus will be tied up on the pond bottom.

On small ponds, less than 5 acres in size, 1 well located platform is usually sufficient. On larger ponds, 1 platform should be provided for each 8 to 10 surface acres.

There is no danger of a fish kill from too great a concentration of fertilizer when using these platforms. In fact, small fish tend to congregate in large numbers right over the fertilizer materials, with no ill effects. Fishermen have found that these platforms also furnish excellent hiding places for large bass.

190. Jurgens, Kenneth C. and William H. Brown. 1954. CHILLING THE EGGS OF THE LARGEMOUTH BASS. Progressive Fish-Culturist, Vol. 16, No. 4, October, pp. 172-175.

Effects of low temperatures during the spawning season of the largemouth bass were observed in an experiment on eggs taken from a pond at the Heart O'Hills State Fish Hatchery near Ingram, Kerr County, Texas. The first phase of this experiment was an attempt to determine the effect of sudden chilling upon the eggs of largemouth bass. For this it was necessary to simulate as far as possible the sudden, late relatively mild, spring northers which have plagued hatchery bass production in Texas for many years. These northers have, characteristically, occurred late in the bass spawning season and have apparently been the cause of hatching failures.

The second phase of this experiment was intended to simulate severe, relatively prolonged cold spells which cause hatching-pond temperatures to fall rapidly and to remain low for a comparatively longer period of time.

The evidence seems to disprove the theory—held by many who are concerned with the pond culture of largemouth bass—that cold weather late in the spawning season is directly responsible for the loss of bass eggs while they are still in the nest.

Chilling as a result of lowered temperature of the pond water does not seem to be the direct cause for the spoiling of the eggs. However, another explanation for the loss of the eggs seems likely. It is probable that the male parent, whose function it is to guard and fan the nest during the egg stage of the young bass, deserts the nest with the lowering of the water temperature. The result of his action is that the eggs are left without aeration, and death follows.

Furthermore, the late cold spells are usually accompanied by strong winds. These winds increase wave action and roil the water, multiplying many times the amount of silt which could accumulate on the eggs. This accumulation of silt on the nest could also cause suffocation of the eggs.

191. Reid, Kenneth A. 1954. CHECK DAMS TO MAINTAIN TROUT STREAMS. Progressive Fish-Culturist, Vol. 16, No. 4, October, pp. 169-171.

This paper outlines a method whereby check dams are used to retain water in trout streams during the dry seasons. Water released from the watersheds when required has increased the use of trout streams for fishing throughout the year. In some instances, also, the watersheds actually held and could provide more water than anticipated.

192. Hundley, Louis R. 1954. A CHECK ON TWO METHODS OF ESTIMATING FARM FISHPOND POPULATIONS. Progressive Fish-Culturist, Vol. 16, No. 4, October, pp. 163-168.

The primary objective of this investigation was to compare the accuracy of estimates of fish populations obtained by use of two sampling techniques with the population figures derived from a total count of fish recovered after drainage of a pond.

The Upper Pond on the campus of the Virginia Polytechnic Institute at Blacksburg, Virginia, was chosen for the study area. This pond has an area of 2 1/2 acres, and an average depth of 3.22 feet. In

December 1949, the pond was stocked with large-mouth bass and bluegills at the ratio of 1,000 bluegills to 200 bass fingerlings per acre of water. No other fish were known to be in the pond at the time of restocking.

Formulas used were: $P = SAB/SC$, suggested by Krumholz (1944) for estimating fishpond populations where P is the total population, S is summation, A is number of animals examined each day (or each pass of the seine), B is the number of marked fish in the study area, and C is the number of returns.

Schumacher and Eschmeyer (1943) used this formula: $N = Sn^2 (m+u)/S(nm)$ to determine the population of fishponds in which N is total population, S is summation, n is the number of marked fish in the pond, m is the number of recaptures in each sample, and u is the number of unmarked fish in each sample. Schumacher and Eschmeyer calculated the sampling variance, s^2, by the following formula in which k stands for the number of samples taken from the pond: $s^2 = \frac{1}{k-1}\left[S\left(\frac{m^2}{m+u}\right) - \frac{1}{N} S(nm)\right]$. The standard error of the Schumacher and Eschmeyer population estimate was computed with the formula

$$S.E. = \sqrt{N^2 \frac{Ns^2}{S(nm)}}.$$

A comparison between the counted and estimated fish populations was made. If it is assumed that the same percentages of marked and unmarked fish escaped during the counting process, the corrected population estimate for bluegills and pumpkinseeds would be 4,786/0.873 or 5,482, which gives 13.3 percent deviation from the estimate arrived at by the Krumholz formula. (The percentages of deviation were calculated in regard to the counted population.) Likewise, the bass population estimate would be corrected to 221/0.906 or 244, which gives a deviation of 47.0 percent. The low bass population or difficulty in catching bass may account for the great deviation.

193. Parry, E. P. and A. L. McClelland. 1954. A FIELD METHOD OF ESTIMATING SOLUBLE INORGANIC PHOSPHATE IN NATURAL WATERS. Progressive Fish-Culturist, Vol. 16, No. 4, October, pp. 158-162.

Determination of phosphate phosphorus in ponds and streams is of prime importance to the aquatic biologist because this constituent is frequently the limiting factor in the productivity of plant growth, which in turn determines the fish yield of a given water area. According to Moyle (1945, 1949), the optimum phosphorus concentration for greatest fish yield is in the range from 0.1 to 0.2 part per million. As most Connecticut ponds have concentrations much lower than this (Conn. Geol. and Nat. Hist. Surv., 1942), any method for analysis of phosphorus in these waters must be applicable to a concentration range of about 0.01 to 0.2 part per million. This investigation was undertaken to develop a rapid and easy method that could be used either in the field or in the laboratory to determine phosphorus in the range of concentrations found in natural waters.

The most widely used and best-known method for determining traces of phosphate is the molybdenum blue method. This method was adapted to field use. Details of preparation of color standards, construction of a comparator and procedure for running tests are given.

Accuracy of the method was tested on synthetic samples of phosphate and values which agreed within 5 parts per billion were obtained. Tests performed have indicated the reliability of this method for the determination of soluble phosphate in natural waters.

194. DeWitt, John W., Jr. 1954. A SURVEY OF PRIVATE TROUT ENTERPRISES IN THE WEST. Progressive Fish-Culturist, Vol. 16, No. 3, July, pp. 147-152.

A survey of private trout businesses in nine Western States was conducted in 1952 and 1953. The States included in the survey were California, Oregon, Washington, Nevada, Colorado, Utah, Wyoming, Montana, and Idaho. The general purpose of the survey was to obtain an idea of the nature, extent, and location of private live-trout enterprises of all kinds.

The "fish-breeder" permit is issued for the culture of any one or more of several kinds of fishes, such as minnows for bait, warm-water game fish, or trout. Questionnaires were sent to virtually all of the permittees.

Twenty-nine and three-tenths percent (185) of the 628 questionnaires were returned in various stages of completion. Because there was no means of determining how nearly random this sample was, it was decided to report the findings only, with no speculation as to how accurately the sample represented the entire group of fish breeders. The data presented and conclusions drawn are therefore based on the sample of 185 returns unless otherwise indicated.

195. Phillips, Arthur M., Jr., Reed S. Nielsen and Donald R. Brockway. 1954. A COMPARISON OF HATCHERY DIETS AND NATURAL FOOD. Progressive Fish-Culturist, Vol. 16, No. 4, October, pp. 147-157.

Most of the ingredients of diets fed to hatchery trout are foreign in the sense that the fish would seldom receive them in the natural environment. The composition of hatchery diets is based largely upon the results of feeding trials, and these usually are judged on the basis of growth, mortality, conversion, and the cost of production. In recent years definite nutritional deficiencies have been recognized, and supplements are added to the diet now to prevent the appearance of the known nutritional disorders. In formulating diets for hatchery fish, little or no attention has been given to the natural food of trout.

Probably one of the reasons for this lack of study of natural food is the general belief that hatchery diets are more efficiently converted into fish flesh than are the natural foods of trout. A review of the literature fails, in general, to support this contention. Hatchery foods now in use will convert at a rate of about 3.0 pounds of food per pound of fish. Values for natural foods have been found that range from 2.3 to 7.1. In almost every instance where the higher values have been reported, underfeeding of

the fish is evident in the experimental design.

For the past two years, through cooperation of several field workers, the Cortland Laboratory has received samples of natural food to be used in analytical studies. This paper may be considered as a progress report on the work.

When all of the analytical results are taken into consideration, it may be concluded that, from the point of view of the nutritionist, the hatchery diet is apparently superior to the natural foods studied. In all but one instance (riboflavin), the chemical content of the hatchery diet is well above that of the natural foods.

196. Hancock, Hunter McRae. 1954. INVESTIGATIONS AND EXPERIMENTATION RELATIVE TO WINTER AGGREGATIONS OF FISHES IN CANTON RESERVOIR, OKLAHOMA. Part I of a report to the Okla. Fish and Game Council in partial fulfillment of the requirements for the degree of Doctor of Philosophy, 104 pp.

Investigations of causes surrounding winter aggregations of fishes, particularly of white crappie, in certain coves of Canton Reservoir, Oklahoma, were conducted in two successive phases during the winters of 1950-51-52. The Boatdock Cove, characterized by inflowing seepage water, contained the initial major aggregation reported by Buck and Cross (1952) during the winter of 1949-1950. The Big Bend Cove, utilized as a control area, received no detectable inflow of water and could not be associated with previous aggregations of fishes.

Appraisal of the effects of the inflowing water on the colder waters of the Boatdock Cove and investigations of other influences possibly bearing on the grouping behavior of fishes were the objectives of the 1950-1951 phase of research.

From evidence obtained during the 1950-1951 phase of research, it was hypothesized that winter aggregations of white crappie in the Boatdock Cove of Canton Reservoir were governed by a composite of the following conditions and eventualities: (1) existence in the reservoir of an adequate population of fish sensitive to contrasting water temperatures in winter; (2) consistent ingress of ground-heated water into the cove; (3) rapid cooling of reservoir waters to temperatures below 4° C. by sudden and severe weather change; (4) formation of persistent ice coverage; and (5) manifestation of a stable, albeit gentle, water temperature gradient throughout the cove.

The cardinal objective of the final phase was to demonstrate induced winter aggregation in an area of water wherein none had previously occurred. To this end, the Haag Cove was selected as an experimental area wherein the factors hypothesized to have influenced gradient expression and crappie aggregation in the Boatdock Cove were to be duplicated as closely as possible.

A washed-out dam immediately above the head of the Haag Cove was repaired and a pond impounded behind it. Emergence of appreciable amounts of ground-heated seepage water, gradient manifestations, and increased trap yields were evidenced within two weeks after repairment of the dam—six days after complete filling of the pond.

By the close of the 1951-1952 phase of research, little doubt remained that significant concentrations of white crappie and white bass had, on several occasions, occurred in both the Haag and the Boatdock Coves, and that the hypothesis of the preceding winter had been validated. No aggregation was apparent in the Big Bend Cove.

197. Alderdice D. F., J. R. Brett, D. R. Idler and U. Fagerlund. 1954. FURTHER OBSERVATIONS ON OLFACTORY PERCEPTION IN MIGRATING ADULT COHO AND SPRING SALMON—PROPERTIES OF THE REPELLENT IN MAMMALIAN SKIN. Fisheries Res. Bd. of Canada, Progress Report of the Pacific Coast Stations No. 98, April, pp. 10-12.

Since 1951 it has been recognized that odours associated with the skin of some mammals could arrest the upstream migration of adult salmon. Water rinses of human skin and other animal skin presented to coho (Oncorhynchus kisutch) and spring salmon (O. tshawytscha) were found to inhabit upstream movement for periods up to 15 minutes following introduction of dilute solutions of these odours.

It is possible that the active component of skin which produces the alarm reaction may have a useful application in deterring salmon from physical barriers or polluted areas. Used in conjunction with attracting stimuli, salmon could be directed to an alternative course around obstacles to migration imposed by increasing industrial developments and uses of natural waters.

The ability to detect odours associated with predator animals would appear to have a distinct survival value for migrating salmon. The fine olfactory sensitivity of salmon to such substances as are associated with predator skin is illustrated by the approximate concentration of the repellent material which would arrest upstream migration. Assuming complete mixing of the sample with the water in the pool, calculation indicates that the limits for producing an alarm reaction fall within a range of dilutions of 1 part in 10,000,000 to 1 part in 100,000,000 of the original aqueous extract of seal skin. The true threshold for repellent activity would be lower when it is considered that the aqueous extract tested is itself an aqueous dilution of the water-soluble material obtained from an initial 25-gram sample of skin. Since it is estimated that the repellent does not compose more than 0.1% of the wet weight of skin it therefore appears to have a threshold activity at a dilution of about 1 part in 80,000,000,000.

198. Bartsch, A. F. 1954. PRACTICAL METHODS FOR CONTROL OF ALGAE AND WATER WEEDS. Public Health Reports, Vol. 69, No. 8, August, pp. 749-757.

Every year, increasing energy is being directed toward the control of excessive growths of algae and water weeds. Specific reasons for control vary, but in each case aquatic nuisance control is an attempt to protect or restore water uses that are considered valuable locally. This paper describes various control methods that have been used and important pre-

cautions that determine their safety and effectiveness. The characteristics of algae and its control by growth limitation and algicides are discussed. Water weeds and their physical and chemical control are discussed.

199. Brett, J. R., D. MacKinnon and D. F. Alderdice. 1954. TROUGH EXPERIMENTS ON GUIDING SOCKEYE SALMON FINGERLINGS. Progress Reports of the Pacific Coast Stations, No. 99, July, pp. 24-27.

In order to further research on the problem of diverting downstream salmon migrants, a large experimental trough was built at Lakelse Lake, B. C., in the spring of 1953. The trough was designed to facilitate making controlled experiments on a variety of potential fish-guiding techniques. Constructed of wood, the trough was 58 feet long, 10 feet wide and 3 feet deep. Metal screens at either end permitted water to flow down the length of the trough. At the upstream end two "release pens", each 5 feet square, served to retain the fish prior to a test. Synchronously raised screens released the young sockeye in an identical manner from each pen. At the downstream end were two "recapture pens". A sheet of plate glass, 10 feet long by 3 feet high, divided the downstream end of the trough leading into the recapture pens.

Sluice gates and an inclined flume attached to the upstream end provided constant rates of flow up to a maximum of 1 mile per hour. Dye releases indicated a fairly uniform flow throughout the length of the trough.

Young sockeye salmon were obtained from the Lakelse River counting weir. Approximately 800 to 1,000 were placed in each release pen prior to a test.

Tests with light gave diverse results. When the narrow beam was shone diagonally across half the trough, little if any deflection was obtained. However, when one half the divided area was totally illuminated marked avoidance occurred. Neither amber nor blue filters had any specific effect on deflection which could not be ascribed solely to the intensity of illumination.

No variation or intensity of sound within the limits available produced a detectible response. Deflection experiments conducted at night confirmed these observations.

A rising "screen" of bubbles proved successful as a deflector during periods of daylight. Its effectiveness decreased considerably at night, but was still marked, resulting in an average deflection of 58% for three tests performed after 11 p.m.

The hanging chain technique yielded the most consistent and most promising results of all experiments conducted. On three occasions deflections of 98% and better were obtained. An average of 94% characterized the daylight tests. At night the effectiveness was decreased somewhat, falling to an average of 71% for the limited tests made.

Neither of the two odour types had any appreciable effect as a deterrent. Bursts of dark blue dye acted as a good deflector during the day. However, its effectiveness was eliminated with loss of daylight.

200. Wickett, W. P. and R. A. Pollard. 1954. MEASURING THE OXYGEN SUPPLY TO SALMON REDDS. Progress Reports of the Pacific Coast Stations, No. 99, July, pp. 20-21.

It is often necessary to know whether a stream has a suitable gravel bottom for spawning salmon. This report tells of a standard method of assessing the oxygen supply to salmon redds.

In all streams part of the water flows above the bed and part flows through the ground under the bed and in the banks. It is this invisible groundwater flow which determines whether a stream is suitable for a salmon redd.

Salmon eggs developing in stream gravel require oxygen; if they do not get enough they suffocate and die. The supply of oxygen depends on its concentration in the ground water and on the rate at which this water flows past the eggs. If the oxygen concentration is low, the velocity must be high, and vice versa, to ensure a sufficient supply to the eggs. If the ground water contains no oxygen the eggs will die no matter how fast the flow. For a redd to be good there must be an appreciable flow of well-oxygenated water through the gravel.

In the Ocean Model Laboratory a method for measuring both the permeability of a stream gravel and the pressure gradient in the ground water has been devised, and from these the velocity of the ground water is calculated.

A hollow pipe, pointed, and with a number of fine holes around the bottom, is driven about 10 inches into the stream bed, the depth at which the salmon lay their eggs. The groundwater flows into the holes on one side of the standpipe and out the other side at a rate depending on the pressure gradient across the standpipe. The pressure gradient is measured by dropping some dye into the standpipe and observing how fast it fades; the more quickly the dye gets diluted, the steeper is the pressure gradient. For example, if the dye fades to half its original concentration in 15 minutes the groundwater pressure gradient is equivalent to a slope of 1 inch per 100 feet length of free water surface.

The permeability of the stream bed is measured by observing how fast water will drain out of the standpipe when poured into the top. A Lucite extension tube, topped by a funnel, is screwed on the standpipe. A pailful of water is poured into the funnel. The time taken for the water level in the tube to fall between two marks on the Lucite extension is a measure of the permeability of the gravel in which the standpipe is driven.

The product of these two quantities, the pressure gradient times the permeability, is the velocity of the water flowing through the gravel.

Finally, it is necessary to analyze a sample of the ground water to determine its dissolved oxygen concentration. First the water inside the standpipe is sucked out of the top, whereupon the standpipe fills with ground water through the holes in the bottom. Then a sample is sucked out and analyzed for its oxygen content.

201. Downing, Kathleen M. 1954. THE INFLUENCE OF DISSOLVED OXYGEN CONCENTRATION ON THE

TOXICITY OF POTASSIUM CYANIDE TO RAINBOW TROUT. The Journal of Experimental Biology, Vol. 31, No. 2, June, pp. 161-164.

Industrial waste waters are often discharged into rivers in which the concentration of dissolved oxygen varies considerably, and it is therefore important to know how this will affect the toxicity of the poisons to the fish present. In 1933, Southgate, Pentelow and Bassindale found that when fish were placed in a fixed volume of a solution of potassium cyanide (0.11 p.p.m. cyanide) toxicity decreased as the concentration of oxygen was increased but that the rate at which it decreased fell off as air saturation value was approached.

The present work was undertaken to see if similar results were obtained when fish were tested in a continuous flow of water in which the concentrations of oxygen and cyanide were kept constant. Periods of survival in tests made in this way are less likely to be distorted by the accumulation of metabolic waste products and by depletion of oxygen and poison.

Water containing the desired concentration of oxygen was prepared by mixing suitable proportions of a stream of water saturated with air with a stream which had been deoxygenated by scrubbing with nitrogen. Potassium cyanide solution was added to the combined stream at a constant rate; the poisoned water was then thoroughly mixed and delivered into an enclosed Perspex tank (156 l. capacity). Fish could be introduced into the tank and removed from it through a valve in the top.

In four tests the total variation in the content of dissolved oxygen in the test tank as determined by Winkler's method was between 0.30 and 0.45 p.p.m., but in the remainder the variation was very much less than 0.30 p.p.m. Concentration of cyanide was determined by a modification of Robbie's phenolphthalein method (accurate to within $\pm$ 4%); total variation was less than 0.008 p.p.m. in all except four tests where it was between 0.013 and 0.019 p.p.m. During all tests the temperature in the test tank was within $\pm$ 0.5° of 17° C., and the pH value varied between 7.8 and 8.2.

The fish used in all but one of the tests were yearling rainbow trout (mean length 13.3 cm., standard deviation 1.4 cm.), obtained at the same time from a commercial farm.

Survival times of rainbow trout in concentrations of potassium cyanide in the range 0.105—0.155 p.p.m. cyanide increased with increase in dissolved oxygen concentration between 10 and 100% of air saturation value, the effect being most marked with the lowest concentration of cyanide. The rate of increase of survival time with increasing concentration of oxygen did not appear to fall off as air saturation value was approached. The distributions of survival times which had median values of 3.3 minutes or less were approximately normal, and those with median values of 13.0 minutes or more were approximately log-normal.

202. Vestal, Elden H. 1954. CREEL RETURNS FROM RUSH CREEK TEST STREAM, MONO COUNTY, CALIFORNIA, 1947-1951. Calif. Fish and Game, Vol. 40, No. 2, April, pp. 89-104.

This paper reports results of the first five years (1947 through 1951) of a continuing complete creel census on Rush Creek Test Stream, a 3.7 mile section of a small California trout stream. Rush Creek Test Stream was established to test the success of existing planting procedures and to find ways of improving them. Large in-season plants of marked catchable rainbow trout were made each year, Smaller plants of marked subcatchable rainbow trout and marked fingerling rainbow and brown trout were made in the first three years to determine over-winter survival of such fish. During the five-year census period, 33,431 anglers fished 118,408 hours and caught a total of 65,935 wild and planted trout. Planted trout contributed 59,362 (90 percent) of the total catch, while wild trout contributed 6,573 (10 percent). The estimated total cost of stocking 70,000 catchable rainbow trout during the five years of the census period was $10,500. Placing a value of $10 on a day of trout angling in the Mono-Inyo area of California (based on probable costs to the fisherman), a total recreational value exceeding $300,000 was sustained at Rush Creek mainly by this stocking.

203. Kimsey, J. B. 1954. THE INTRODUCTION OF THE REDEYE BLACK BASS AND THE THREADFIN SHAD INTO CALIFORNIA. Calif. Fish and Game, Vol. 40, No. 2, April, pp. 203-204.

A large part of the warmwater fisheries research program of the California Department of Fish and Game has been devoted to a search for new game species to be used in some of the State's marginal waters, most of which tend to be more suitable for warmwater species. The redeye black bass has been obtained from Tennessee for stocking in streams unsuitable for trout because of high summer temperatures. The second species, the threadfin shad, also obtained from Tennessee, is believed to be an excellent forage species for California's fluctuating reservoirs, since it requires no substrate for spawning, feeds on plankton, does not exceed about seven inches in length, and is very acceptable to game species as food. It is not dependent during its life cycle on the littoral zone, which is so unstable in fluctuating reservoirs.

204. Hubbs, Carl L. 1954. ESTABLISHMENT OF A FORAGE FISH, THE RED SHINER (NOTROPIS LUTRENSIS), IN THE LOWER COLORADO RIVER SYSTEM. Calif. Fish and Game, Vol. 40, No. 3, July, pp. 287-294.

The red shiner, native from the North Central States to northeastern Mexico, has recently become established in the Colorado River and connected waters of Arizona, Baja California Norte, and California, where it is of potential importance in game fish management. The recent great depletion of the limited native fish fauna accounts for the rapid increase of this and other introduced fishes in the lower Colorado River system. The establishment of the red shiner is attributed to escapements from the Arizona Fish Farms near Blythe, California. The stock came from near Lake Buchanan, Texas. The

introduced fish are provisionally regarded as intergrades between N. l. lutrensis and N. l. sauvis, a slender race of the southern coastal plain of Texas. They are not N. mearnsi Snyder, a form of the Gulf of California drainage that should probably be treated as a subspecies of N. formosa (Girard). That form and certain other nominal species, of the interior drainage of the Sonoran Plateau, may also prove to be interpretable as subspecies of N. lutrensis. Notropis forlonensis of the Rio Panuco system in eastern Mexico is definitely so regarded. (A)

205. Collyer, Robert D. 1954. TAGGING EXPERIMENTS ON THE YELLOWTAIL, SERIOLA DORSALIS (GILL). Calif. Fish and Game, Vol. 40, No. 3, July, pp. 295-312.

The yellowtail is extremely important to Southern California sportsmen and is also a commercial variety of some significance. Apprehension by sportsmen over future good fishing for yellowtail resulted in the Department of Fish and Game undertaking a thorough study of the species in 1952.

A major problem was to determine whether or not the fish moved from Mexican waters, where they are most abundant, into California waters. The most direct approach to the problem lay in a tagging program. Consequently, during 1952 and 1953 considerable effort was devoted to the development of suitable tags and to marking fish at sea.

Four types of experiments were performed in developing suitable tags. These included double-tagging at sea, aquarium observations, tests in a water tunnel, and tests of tags attached to the bottom of a vessel. The tags used included: conventional Petersen disks attached by both stainless steel wire and monofilament nylon; opercular tags of several types; streamer tags, some of them hydrostatic; plastic jaw tags and plastic tubing tags similar to those used successfully on tuna.

The tubing tags and the jaw tags have been most satisfactory and their use is being continued. By the end of February 1954, there was no evidence of tag loss from either of these types. The Petersen disks, regardless of the means of attachment, showed serious flaws in all the experiments. This was demonstrated most forcefully by the double tagging work at sea. Of 92 recoveries from fish marked initially with Petersen disks and one of the other types, there were 66 losses of the disks. The other types of tags tested and rejected also showed losses, though not as great as for the Petersen disks.

At the end of February 1954, 3,147 yellowtail had been tagged and released. Recoveries totaled 103, only 13 of which moved more than 10 miles from the point of release. The maximum movement recorded was 240 miles, for a fish at liberty only 62 days. The maximum time out was 213 days, by a fish which moved 90 miles. One yellowtail tagged at the Coronados Islands, just south of the International Boundary was retaken in California waters at Santa Catalina Island. Three fish moved from Guadalupe Island, 140 miles off the coast of Baja California, to the mainland. (A)

206. Pelgen, David E. 1954. PROGRESS REPORT ON THE TAGGING OF WHITE CATFISH (ICTALURUS CATUS) IN THE SACRAMENTO-SAN JOAQUIN DELTA. Calif. Fish and Game, Vol. 40, No. 3, July, pp. 313-321.

During the early part of 1952, 3,466 white catfish were tagged at six different localities in the Sacramento-San Joaquin Delta area of California.

Two different types of tags were used. The return of disk-dangler tags was approximately six times that of opercular strap tags. It is believed that the principal reason for this difference lies in the fact that the strap tag is difficult to see, and is not noticed by anglers.

Migration or movement of the catfish from the point of tagging was quite sporadic and without apparent direction. The fish are capable of covering considerable distances in rather short periods of time. (A)

207. Skinner, John E. and A. J. Calhoun. 1954. FIELD TESTS OF STAINLESS STEEL AND TANTALUM WIRE WITH DISK TAGS ON STRIPED BASS. Calif. Fish and Game, Vol. 40, No. 3, July, pp. 323-328.

In 1951, 1,211 striped bass were tagged on the caudal peduncle with cellulose nitrate disks and three types of wire: tantalum, passivated dead soft stainless steel type 302, and medium soft stainless steel type 302. There were 204 returns (16.85 percent) by February 1, 1954. The elapsed time between tagging and recapture ranged from 0 to 1,005 days. There were no significant differences in the three metals, in either the total proportion returned or the elapsed time between tagging and recapture.

A small but significant difference was noted between the returns as related to the length of the fish. Comparatively fewer small fish were returned with medium soft stainless steel than with tantalum or dead soft stainless steel.

The recovery period in this experiment was significantly longer than in earlier studies, in which nickel and other metals were used with tags beneath the dorsal fin. (A)

208. DeWitt, John W., Jr. 1954. A SURVEY OF THE COAST CUTTHROAT TROUT, SALMO CLARKI CLARKI RICHARDSON, IN CALIFORNIA. Calif. Fish and Game, Vol. 40, No. 3, July, pp. 329-335.

In California the Coast Cutthroat Trout is restricted mainly to the area bounded by the Eel River, the Oregon state boundary line, the Pacific Ocean, and the summit of the Coast Range. The Smith River system is the most important cutthroat area.

The cutthroat may generally be distinguished from steelhead and other trout of the rainbow series by the presence of hyoid teeth and reddish or orange dashes on the throat, as well as by differences in body coloration.

This form is extremely variable in California. Pyloric caecum counts range from 23 to 60; scale rows along the lateral line vary from 122 to 188; hyoid teeth vary from 1 to 34.

Fresh sea-run cutthroat are taken in varying numbers from the main streams within their Cali-

fornia range during the fall and winter. There are indications that some coast cutthroat do not migrate to sea and constitute resident, breeding populations.

Fish-of-the-year were found only in the very smallest tributary streams, usually those with summer flows less than one cubic foot per second. (A)

209. Dill, William A. and Leo Shapovalov. 1954. SALMO ROSEI, NOT A VALID SPECIES. Calif. Fish and Game, Vol. 40, No. 3, July, pp. 337-338.

In view of the combined evidence presented, it is concluded that Salmo rosei is a synonym of Salmo gilberti, now known as Salmo gairdneri gilberti Jordan.

210. Kimsey, J. B. 1954. THE LIFE HISTORY OF THE TUI CHUB, SIPHATELES BICOLOR (GIRARD), FROM EAGLE LAKE, CALIFORNIA. Calif. Fish and Game, Vol. 40, No. 4, Oct., pp. 395-410.

Eagle Lake, Lassen County, California, is an alkaline lake lying in a closed basin, with only intermittent inlet streams. Although the lake surface is now lowered as a result of both evaporation and irrigation, it has fluctuated widely in the past through natural causes.

The writer considers the tui chub of Eagle Lake a hybrid population, Siphateles bicolor: obesus X pectinifer, in which a peculiar bimodal gill-raker pattern exists. No correlation could be detected between the gill-raker counts and any other character ordinarily used to differentiate these forms.

The adults feed primarily upon the larger zooplankton, higher plants, and insect larvae. Newly-hatched fish begin to feed almost immediately upon rotifers, desmids, diatoms, and other microscopic material.

The tui chub spawns when the water temperatures are approximately 60 degrees F., laying its adhesive eggs on plants in water not over three or four feet deep.

It inhabits the shore areas and shallows during its first year. After that, it returns to these areas only during the spawning period.

In Eagle Lake it attains a mean standard length of 6.6 cm. (2.7 inches) at the end of the first year, 11.2 cm (4.4 inches) in its second year, 16.7 cm. (6.6 inches) in its third, 21.6 cm. (8.5 inches) in its fourth, 24.9 cm. (9.8 inches) in its fifth, 28.1 cm. (11.1 inches) in its sixth, and 32.5 cm. (12.8 inches) in its seventh. The maximum size recorded (unaged) was 40.9 cm. (16.0 inches). Lengths of age groups were calculated from scale measurements.

The species may prove useful as a forage fish in fluctuating reservoirs. (A)

211. Herald, Earl S., Robert P. Dempster and Howard McCully. 1954. THE EFFECT OF AUROFAC-ENRICHED DIET (AUREOMYCIN AND B_{12}) UPON YOUNG KING SALMON. Calif. Fish and Game, Vol. 40, No. 4, Oct., pp. 415-421.

During the past few years many aquarists and aquatic biologists have been experimenting with the antibiotics, as both therapeutic agents and dietary supplements. This has resulted in a variety of claims and statements—many of conflicting nature. Upon examination of these two phases as they relate to fishes, a prompt conclusion is reached that some of the antibiotics are certainly effective as therapeutic agents—but under specific conditions. Preliminary studies at Steinhart Aquarium have dealt with this dietary problem and are described in this paper. It should be pointed out that primary interest was in the use of antibiotics as growth supplements and not as a source of protein or of carbohydrates.

212. Bailey, Reeve M. and Frank B. Cross. 1954. RIVER STURGEONS OF THE AMERICAN GENUS SCAPHIRHYNCHUS: CHARACTERS, DISTRIBUTION, AND SYNONYMY. Papers of the Mich. Academy of Science, Arts and Letters, Vol. 39, Part II (Zoology), pp. 169-208.

This is a taxonomic study of two species of the genus Scaphirhynchus. S. platorynchus (Rafinesque) is the more common and widely distributed species and is the subject of considerable commercial exploitation. S. album (Forbes and Richardson) was not described until 1905 and remains one of the least known of our larger freshwater fishes. The recent accumulation of new material of both forms enabled the authors to verify their specific, though not generic, distinctness, present descriptive measurements and meristic counts, contrast the species in certain differential characters, list new records of specimens, and map the known geographic ranges.

213. Cooper, Gerald P. and William C. Latta. 1954. FURTHER STUDIES ON THE FISH POPULATION AND EXPLOITATION BY ANGLING IN SUGARLOAF LAKE, WASHTENAW COUNTY, MICHIGAN. Papers of the Michigan Academy of Science, Arts and Letters, Vol. 39, (Part II Zoology), pp. 209-223.

Estimates of the fish population of Sugarloaf Lake, in Washtenaw County, Michigan, were made in the fall of 1948, and again the springs of 1949, 1950, and 1951 (Cooper 1953). The present study, done in 1952, is a continuation of the series.

Netting in Sugarloaf in 1952 was done at 173 stations. The stations were fished in numerical sequence during the period of September 18 to October 22, 1952, by means of five trap nets. Each station was fished by only one net and for only one overnight set, except that nets were returned to the "repeat" sites according to the numerical netting schedule.

In the present study, the fish population estimate and the angling records are limited to bass 10 inches or more in length, pike, gar and bowfin 14 inches and over, and all other species 6 inches and over. During the trap-netting, daily observations on the lake failed to reveal more than an insignificant number of dead fish, and this indicated that the netting did not cause enough mortality to interfere with the population estimate.

The population estimates of legal-size fish in Sugarloaf Lake in the fall of 1952, for those species for which there were sufficient numbers of recaptures, were calculated by the Schumacher and Eschmeyer (1943) formula, and also by the Schnabel (1938) formula. The total population, obtained by summation of estimates for individual species, was 17,077 by the Schumacher and Eschmeyer formula, or 16,317 by the Schnabel formula. The estimates for 1952 compares favorably with those for the four previous years.

Mortality and exploitation rates were determined by the method described by Ricker (1945). Results for a five-year period are given for six species.

214. Hooper, Frank F. 1954. LIMNOLOGICAL FEATURES OF WEBER LAKE, CHEBOYGAN COUNTY, MICHIGAN. Papers of the Mich. Academy of Science, Arts and Letters, Vol. 39, (Part II Zoology), pp. 229-240.

Observations made on Weber Lake, Cheboygan County, Michigan, show that the lake is unique in having its lowest concentration of pH, bicarbonate, calcium, magnesium, sodium, potassium, and sulphate in the thermocline region.

The pH increase in the hypolimnion was greatest the year in which the alkalinity of this stratum was highest, which suggests that the bicarbonate that accumulates in the hypolimnion brings about the observed increase in pH.

There is evidence that the lake basin is sealed, so that its alkalinity is not influenced by ground water in the surrounding area, other than the seepage from an adjacent bog.

The lake has little rooted aquatic vegetation and a poor plankton flora, consisting chiefly of dinoflagellates and chrysophycean algae.

The summer zooplankton consists chiefly of rotifers and contains few Entomostraca.

Midge larvae and Pisidium sp. were the predominant bottom-fauna organisms. (A)

215. Bigelow, Henry B. and William C. Schroeder. 1954. FISHES OF THE GULF OF MAINE. U. S. Fish and Wildlife Service Fishery Bulletin 74, First revision, 577 pgs.

This is a handbook for the easy identification of the fishes that occur in the Gulf of Maine, with summaries of what is known of the distribution, relative abundance, and more significant facts in the life history of each. The descriptions are as little technical as is compatible with scientific accuracy, and are limited chiefly to such of the external features of each kind of fish as may serve for identification in the field.

Keys are provided for all species as a further aid to identification. It is well illustrated.

216. 1954. GULF OF MEXICO, ITS ORIGIN, WATERS, AND MARINE LIFE. Fishery Bulletin of the Fish and Wildlife Service No. 89, Vol. 55, 604 pgs.

The purpose of this book is to summarize in a convenient form the present knowledge about the Gulf of Mexico. It was prepared by 55 American scientists under sponsorship of the Fish and Wildlife Service and was coordinated by Paul S. Galtsoff.

The book comprises a number of articles each written by a recognized authority in his field; these are arranged, with minor exceptions, in a taxonomic order following a list of phyla, classes, and orders prepared in 1936 for the American Association for the Advancement of Science and published by Duke University Press. This plan was carried out with the following exceptions: the sections on Rotatoriá and Branchiopoda were omitted because of the inability to find anyone willing to review these two groups; and, for the sake of convenience, the articles on parasitic worms were assembled in a single chapter.

A pertinent bibliography is given at the end of each section.

217. Rice, Theodore R. 1954. BIOTIC INFLUENCES AFFECTING POPULATION GROWTH OF PLANKTONIC ALGAE. U. S. Fish and Wildlife Service Fishery Bulletin No. 87, Vol. 54, 18 pgs.

A culture medium in which both Chlorella and Nitzschia would grow well was devised so that the effect of each on the other could be tested when grown together in the same medium. An increase in inhibition of the growth rate of Chlorella populations of the same size was demonstrated with an increase in the number of Nitzschia cells used to start the culture. A similar increase in inhibition of growth rate of Nitzschia cells required a relatively larger increase in the number of Chlorella cells used to start the cultures.

If culture medium in which either Chlorella or Nitzschia had been growing was Berkefeld filtered, the pH adjusted, and nutrients added, it was found that the growth rates of both species were inhibited when they were again grown in this medium. However, if a portion of this medium was also washed with Norit A and autoclaved the growth rate of neither species was inhibited. It was therefore concluded that the antagonistic substances produced by the algae were either removed or destroyed by the latter treatment. The growth rates of both Chlorella and Nitzschia were also inhibited in culture medium prepared from pond water that had supported a bloom of Pandorina for a period of 2 weeks.

It is concluded that antagonistic substances arising from the metabolism of phytoplankton are important, at least in fresh-water ponds, in influencing the seasonal fluctuations in total phytoplankton numbers and in numbers of each species, and in inducing a definite succession of the phytoplankton. (A)

218. Fredin, Reynold A. 1954. CAUSES OF FLUCTUATIONS IN ABUNDANCE OF CONNECTICUT RIVER SHAD. U. S. Fish and Wildlife Service Fishery Bulletin 88, Vol. 54, 12 pgs.

This paper presents a method of analyzing catch, fishing effort, and tagging data which was used to estimate the size of the shad runs in the Connecticut River for each year in the period 1935-51. Using these estimates, further analysis indicated that more than 80 percent of the fluctuations in the

size of these runs can be explained by changes in the size of the escapements from the fishery.

An estimate of the mortality outside the river acting on a group of adult shad in the period between the 1946 and 1947 fishing seasons indicates that such mortality may also exert an effect on the size of the runs entering the river.

Investigation of the Connecticut River shad fishery is part of a 6-year, coastwise study of the Atlantic shad (Alosa sapidissima) sponsored by the Atlantic States Marine Fisheries Commission. Research conducted by the United States Fish and Wildlife Service, with the cooperation of the various State agencies along the Atlantic coast, has been undertaken to determine the factors affecting the abundance of shad and to recommend measures for restoring the species to its former abundance. (A)

219. Collins, Gerald B., Charles D. Volz and Parker S. Trefethen. 1954. MORTALITY OF SALMON FINGERLINGS EXPOSED TO PULSATING DIRECT CURRENT. U. S. Fish and Wildlife Service Fishery Bulletin No. 92, Vol. 56, 20 pgs.

Influences of voltage gradient, current density, pulse frequency, and duration of exposure on the mortality of salmon fingerlings exposed to pulsating direct current were examined experimentally in relation to the length of fish, water temperature, and pulse duration, using a current of square-wave form.

The experiments indicated that mortality increased with an increase in voltage gradient, in current density, or in both. The effect of voltage gradient increased with the duration of exposure. The total voltage to which the fish were subjected (fish length X voltage gradient) was the effective factor in mortality, rather than the voltage gradient, and the effect of total voltage on mortality was actually greater on shorter fish when the exposure was only 30 seconds. Pulse duration was not a lethal factor, and there was no direct relation between mortality and the total energy applied per unit of time. Under the conditions of these experiments, mortality increased with the pulse frequency, and the effect of pulse frequency on mortality increased with the length of the fish and the duration of exposure.

The mortality of the fingerlings exposed to pulsating d.c. increased with the duration of exposure, and the effect of duration of exposure increased with the length of the fingerlings. Mortality increased with the water temperature, and the effect of water temperature on mortality increased with the duration of exposure. The effect of water temperature on mortality was greater on fish of greater length. (A)

220. 1954. ATLANTIC SALMON (SALMO SALAR). U. S. Fish and Wildlife Service Fishery Leaflet 176, revised March, 6 pgs.

Atlantic salmon were once abundant in most larger New England rivers and in many smaller streams. The Hudson River in New York was possibly the extreme southern limit of their range, which extended as far north as the Arctic Circle. Today there are only remnants of the New England runs, in the Penobscot and Dennys Rivers and a few streams in the eastern part of Maine. In Canada, rivers of the Maritime Provinces still have substantial runs. Destruction of the runs in New England was due to heavy fishing, deforestation, pollution, and construction of dams and other barriers to migration.

The life history of the species is presented.

The success or failure of any salmon-restoration program lies in the condition of the streams. Abatement of pollution, construction of fishways, and screening of water diversions may eventually restore many rivers. With river conditions better today than in former years, it is hoped that the runs can be restored eventually in much of the Atlantic salmon's former territory.

221. 1954. PACIFIC SALMONS. U. S. Fish and Wildlife Service Fishery Leaflet 14, revised March, 8 pgs.

Five species of salmon inhabiting the waters of the Pacific coast of North America are described in this report. Their range, fresh-water life, ocean life, age at maturity, length and weight and time of run are discussed for each species. These are the pink or humpback salmon, the king or chinook salmon, the red, sockeye or blueback salmon, the silver or coho salmon, and the chum, keta, or dog salmon. These five species belong to the genus Onchorhyncus of the family Salmonidae (salmons and trouts).

Landings and wholesale-market value, 1947 through 1952, of the five species are also shown.

222. 1954. EARTHWORMS FOR BAIT. U. S. Fish and Wildlife Service Leaflet FL-23, revised June 1952, 3 pgs.

This brief paper setsforth information on various methods of collecting earthworms, instructions on how to raise and store them both indoors and outdoors, tells how to harvest them and how to keep them alive in the bait box while they are being used in the heat of the sun, and how to prepare them for market.

223. 1954. LIST OF FEDERAL FISH-CULTURAL STATIONS. U. S. Fish and Wildlife Service Leaflet FL-147, revised November, 5 pgs.

This is a list of 91 fish cultural stations in 42 States and the Regional Offices having jurisdiction over their operations.

224. Surber, Eugene W. 1954. CONTROL OF AQUATIC PLANTS IN PONDS AND LAKES. U. S. Fish and Wildlife Service Fishery Leaflet No. 344, (reissue), 20 pgs.

The purpose of this leaflet is to aid fish-culturists, pond owners, and operators who have weed-control problems. The methods of weed eradication and control described herein apply to farm ponds, hatchery ponds, and small lakes.

Methods are described for the eradication and control of (1) the submersed plants such as the American waterweed (Anacharis) and the many

species of pond-weeds (Potamogetons), etc., which are rooted in the pond bottom and grow to the water surface, and (2) the emergent plants, such as cattails, softstem bulrush, burreed, willows, etc. which usually start their growth at the margin of a pond and build up marshes about its border. Photographs of some types of equipment are included.

225. Ginsburg, Isaac. 1954. FOOD FISHES WITH FINS AND SCALES. U. S. Fish and Wildlife Service Fishery Leaflet 418, August, 9 pgs.

This paper gives the anatomy of fishes in its bearing on the requirements of certain religious dietary regulations, with a note on the source of cod and other liver oils in non-technical language. A partial list of common food fishes that do have both fins and scales is included in the paper.

226. Maciolek, John A. 1954. ARTIFICIAL FERTILIZATION OF LAKES AND PONDS. U. S. Fish and Wildlife Service, Special Scientific Report Fisheries No. 113, January, 41 pgs.

Artificial enrichment and the environmental factors associated with it are treated in order to describe the fertilization processes and relate them to various fields of fresh-water fisheries. The literature reviewed is largely North American, but pertinent Asiatic and European reports are included.

227. Walburg, Charles H. 1954. EXPERIMENTAL TRANSPORTATION OF LIVE SHAD PAST SUSQUEHANNA RIVER DAMS. U. S. Fish and Wildlife Service, Special Scientific Report-Fisheries No. 114, January, 13 pgs.

The purpose of this experiment, conducted in the spring of 1952, was to determine the feasibility of transporting shad for long distances and transplanting them. Information concerning the success of spawning of the transplanted shad, the survival of young, and the mortality suffered by juveniles and by adults in descending the dams was also desired.

During the spring of 1952, 1,184 adult shad were transported from the head of Chesapeake Bay near Perryville, Maryland, to stocking locations above Conowingo and Safe Harbor Dams on the Susquehanna River. All but 19 fish were tagged before release.

Of the shad planted above Conowingo Dam, 89 percent survived to point of planting, while of those planted above Safe Harbor Dam, only 68 percent survived. Thus, the survival rate of the shad decreased as the hauling distance increased. It was believed that a higher survival rate would have been obtained if the hauling tanks had been larger and arranged so that the shad could swim and respire in a normal manner.

Forty of the tagged shad were retaken by the commercial fishery in Maryland. Most of the shad that descended the dams probably came through the floodgates. Authentic reports indicate that a large number of the planted shad died above the dams. Attempts were made to locate juvenile shad in order to determine the success of spawning of the planted shad, but none were found.

From tag recoveries it was determined that 51.6 percent of the shad present were taken by the commercial fishery during the 1952 shad season and that 77 of the planted shad passed downstream over Conowingo Dam. There was no significant difference between the survival rate of the shad planted above Conowingo Dam and that for the shad tagged at the head of Chesapeake Bay.

228. Nesbit, Robert A. 1954. WEAKFISH MIGRATION IN RELATION TO ITS CONSERVATION. U. S. Fish and Wildlife Service Spec. Scientific Report: Fisheries No. 115, January, 81 pgs.

The complex movements of weakfish have been studied by comparing the stocks of fish at several localities as to abundance, size, age composition, and rate of growth, and by tagging experiments.

Adult distributions are significantly different from the juvenile distributions characteristic of the areas in which the adults were taken. The difference is such as to suggest that the adults in each area represent a mixing of the weakfish from two or more nursery areas.

Weakfish eggs and larvae are abundant in Chesapeake Bay and southward, but larvae have never been found north of the entrance to Chesapeake Bay. Numerous eggs have been found in Delaware Bay in spring, but extensive sampling has revealed no larvae. Juveniles found there in the spring probably have moved northward from southern spawning areas.

The hypothesis concerning the movements of the weakfish is supported by an analysis of age, size, rate of growth, and scale circuli measurements. Tagging experiments partially support the hypothesis and in addition indicate that North Carolina sounds do not contribute materially to the northern stocks.

The most important conclusion to be derived from this study is that the fishery apparently draws on a common stock which originates chiefly in southern waters. Consequently, any conservation policy for the weakfish industry must consider the effect of fishing intensity on the total yield of the Middle Atlantic Bight.

229. Lennon, Robert E. 1954. ANGLING ON LITTLE PIGEON RIVER, GREAT SMOKY MOUNTAINS NATIONAL PARK, 1953. U. S. Fish and Wildlife Service, Special Scientific Rpt. - Fisheries No. 121, April, 27 pgs.

The Little Pigeon River was chosen for a creel census because the mainstream and its tributaries have a history of good fishing and they have long been subjected to a heavy fishing pressure. The largest tributary, Porters Creek, suffered severe flood damage in September 1951, and it was generally assumed that its fish population was destroyed; hence it was a matter of interest and importance to determine the recovery of this stream in terms of angling results. Parts of the drainage are planted with legal-size brook and rainbow trout each year, and the contribution these fish make to the creel could be estimated and compared with the yields of wild trout from the same and adjacent waters.

Finally, some of the best waters in the Little Pigeon area are available only to those fishermen who are willing to walk considerable distances, thereby making possible an analysis of the distribution of fishing pressure in terms of stream accessibility.

The streams of the Little Pigeon River watershed continued to provide fair quality trout fishing during the 1953 season. According to creel census data, there were 59 anglers per mile of fishable water, 33 of whom were successful and caught 168 legal trout per mile at a rate of 1.4 fish per hour.

A total of 1,200 fishermen reported at the creel checking station, and 3,443 trout were tallied. The mean hourly catch rate for all anglers was 0.8 fish; the average creel was 2.9 trout and weighed 10 ounces. It was estimated that records include two-thirds of the actual numbers of fishermen and trout captured, that there were actually about 1,800 anglers on the watershed and about 5,000 trout caught during 1953.

Most of the stocked rainbow and brook trout were removed from the streams shortly after the season opened. The estimated recovery for both species was 65 and 64 percent, respectively. Wild rainbow trout provided the bulk of fishing throughout the summer, whereas wild brook trout made an insignificant contribution to the total catch.

The combination of liberal fishing regulations in effect from 1948 through 1952 and a heavy fishing pressure has contributed to a lack of parent stock and a decline in trout numbers. The population surveys showed less than 500 rainbow trout per mile in the Little Pigeon, Middle Prong, and Porters Creek. There were more trout per mile in Ramsey Prong where the angling pressure is less heavy.

230. Graham, Herbert W. and John M. Amison and Kenneth T. Marvin. 1954. PHOSPHORUS CONTENT OF WATERS ALONG THE WEST COAST OF FLORIDA. U. S. Fish and Wildlife Service Spec. Scientific Rpt.: Fisheries No. 122, April, 43 pgs.

The distribution of inorganic and total phosphorus in the waters along the west coast of Florida is reported for a period of more than 16 months. Some upwelling to subsurface levels is evident but no hydrographic feature occurs which could account for the high values of phosphorus found during the "red tide" of 1946-1947. There is no evidence that either leaching from the bottom of the Gulf or outflow from local rivers contributes large quantities of phosphorus to the Gulf waters. However, values of total phosphorus comparable to those of the red tide were found in blooms of Trichodesmium floating on the surface over water of very low phosphorus content. (A)

231. Newman, H. William, David D. Palmer and Roger E. Burrows. 1954. TESTS OF HATCHERY FOODS FOR SALMON, 1952. U. S. Fish and Wildlife Service Spec. Scientific Rpt.: Fisheries No. 124, April, 12 pgs.

The feeding trials conducted in 1952 at the Entiat Salmon-Cultural Laboratory were a continuation of feeding experiments conducted annually since 1944 (Burrows et al. 1951, Robinson et al. 1951a, Robinson et al. 1951b, and Burrows et al. 1952). Both blueback salmon (Oncorhynchus nerka) and chinook salmon (O. tshawytscha) were used as the test animals.

Two experiments were run simultaneously, each for a 12-week cold-water period followed by a 12-week warm-water period, with the exception that two of the diets in the first experiment were tested under the cold-water conditions only.

The first experiment, utilizing blueback salmon fingerlings, contained the following tests: (1) dry meal toxicity tests in which vitamin supplementation reduced the mortality, (2) meal evaluations wherein two meals were found to be comparable to the control, and (3) potential production diets composed of two different groups. Substitutions in the standard blueback diet to avoid the use of beef liver and hog spleen comprised one group; the other was a series utilizing a 50 percent salmon viscera base and various combinations of meat and fish products. A good production diet resulted from each group.

The second experiment, using chinook salmon fingerlings, embodied a retesting of combinations already found practicable as food for blueback salmon fingerlings. Four of the best meat-viscera mixtures of the 1951 trials with blueback salmon were compared with the standard chinook ration. These tests provided an additional comparison of the requirements of chinook and blueback salmon which were found to be similar in 1951.

232. Applegate, Vernon C., Paul T. Macy and Virgil E. Harris. 1954. SELECTED BIBLIOGRAPHY ON THE APPLICATION OF ELECTRICITY IN FISHERY SCIENCE. U. S. Fish and Wildlife Service, Spec. Scientific Rpt.: Fisheries No. 127, April, 55 pgs.

Applications of electricity in commercial fishing, in fish-salvage operations, and as a research tool are growing rapidly in importance.

This bibliography includes reports appearing through the calendar year 1953 which are directly or indirectly related to the application of electric current in or to the water for the purpose of influencing or controlling fish movement or for capturing fishes or other aquatic organisms. Similar uses of light and sound are not included. Coverage of the literature on fundamental researches of the reactions of fishes to electrical stimuli is comprehensive. A selection of references in the general field of electrophysiology and on the reactions of organisms other than fishes to electrical stimulation is included.

Coverage of technical and popular accounts of specific applications of electricity in fishery science is likewise comprehensive; both engineering and biological considerations are contained in some of these reports. Further selected reports have been included which may be of aid in instrumentation or which describe useful test instruments. A few papers are cited which discuss the general subject of electrostatic fields; others describe the characteristics of electrical fields in fluid media. Articles dealing specifically with the characteristics of electrical fields in natural waters and the modifying effects of

varying natural conditions on these fields appears non-existent. Some information may be gleaned, however, from several of the reports cited herein which are concerned primarily with other topics.

In addition to the reference material previously indicated, a separate list is presented of patents granted by the United States Patent Office through 1952 which are pertinent to the subject of this report.

233. 1954. CREEL CENSUS AND EXPENDITURE STUDY, NORTH FORK SUN RIVER, MONTANA, 1951. U. S. Fish and Wildlife Service, Spec. Scientific Report #120, May, 39 pgs.

A creel census was conducted on the North Fork Sun River and several associated bodies of water in Montana during 1951 by the Office of Missouri River Basin Studies, Fish and Wildlife Service.

Estimated fishing pressure and yield from approximately 80 miles of the North Fork Sun River (including two reservoirs which had a total surface area of 1,460 acres), during the period May 20 through September 30, 1951, was about 7,201 fisherman-days, and 14,755 fish weighing 6,728 pounds. Essentially all (99.8 percent) of the fish taken were game fish (trout, grayling, and whitefish). The average rate of catch was 0.52 fish per hour or 0.20 pounds of fish per hour.

Estimated fishing pressure and yield from approximately 3,100 acres of water in the associated fisheries, during the period May 20 through September 30, 1951, was about 2,976 fisherman-days and 1,546 fish weighing 2,155 pounds. The catch was composed of about 78 percent trout, grayling, and whitefish, 16 percent pike and yellow perch, and 6 percent suckers. The average rate of catch was 0.11 fish per hour or 0.16 pounds of fish per hour.

About 98 percent of the fishermen contacted during the study were residents of Montana, 72 percent of whom came from Great Falls, Montana, about 50 miles away. All but 7 percent of the fishermen came from within 100 miles of the study area.

Results of the fisherman expenditure study indicated an average per-day expenditure of $6.27, with a range of $5.91 to $10.70 for various segments of the fishery. The average expenditure per pound of fish varied from $4.12 to $12.26 for the various segments of the fishery and averaged $7.41. The total annual value of the fishery is estimated to be $66,000.

234. 1954. CREEL CENSUS AND EXPENDITURE STUDY, MADISON RIVER, MONTANA, 1950-52. U. S. Fish and Wildlife Service Spec. Scientific Rpt.—Fisheries No. 126, April, 39 pgs.

Fishing pressure and yield of 119 miles of the Madison River in Montana, including two onstream reservoirs—Madison and Hebgen—was determined over the three-year period 1950 to 1952.

Estimated annual fishing and yield from the fishery as a whole was 40,772 fisherman-days and 80,459 fish weighing 92,682 pounds. Separated into the component fisheries, i.e., stream (98 river-miles) or reservoir (Madison, 3,800 acres, and Hebgen, 13,200 acres), the annual fishing and yield for the stream fishery was 22,660 fisherman-days and 52,424 fish weighing 48,385 pounds and that for the reservoir fishery was 18,112 fisherman-days and 28,035 fish weighing 34,297 pounds.

Species of fish taken by anglers from the fishery as a whole were: rainbow trout, 65.4 percent; brown trout, 22.1 percent; brook trout, 0.2 percent; cutthroat trout, 0.2 percent; grayling, 0.5 percent; whitefish, 6.6 percent; suckers, 4.5 percent; and Utah chub, 0.6 percent.

Rates of catch in fish per hour and pounds per hour of effort varied from 0.43 to 0.82 and 0.38 to 0.67, respectively, for various areas on the stream and from 0.30 to 0.32 and 0.37 to 0.39, respectively, on the two reservoirs.

The percent of resident fishermen varied from 94 in the Lower Section to 45 in the Upper Section. The Upper Section was closest to Yellowstone National Park.

Results of the fisherman-expenditures study indicated an average per-day expenditure of: Lower Section and Madison Reservoir, $7.90; Middle Section, $7.95; and Upper Section and Hebgen Reservoir, $13.08. The average expenditure per pound of fish for each section of river and reservoir was: Lower Section River, $3.31; Madison Reservoir, $3.47; Middle Section, $3.39; Upper Section, $7.97; and Hebgen Reservoir, $8.21. The total average annual expenditure by fishermen was estimated to be $412,500.

Comparisons were made of the Madison River fishery with other Rocky Mountain streams and reservoirs and of fisherman expenditure data for the Madison River fishery with those for other cold-water fisheries.

235. Johnson, Harlan E. and Richard F. Brice. 1954. USE OF IMPOUNDED WATER FOR FISH CULTURE. U. S. Fish and Wildlife Service Research Report No. 35, 35 pgs.

Tests were made at Dorena Dam Experimental Laboratory, September 1950 to November 1952, to determine the suitability of impounded water for fish culture. Water analyses and hatchery experiments indicated that Dorena water did not contain any toxic substance in high enough concentration to be harmful to salmon or trout. Water from the lower levels of Dorena Reservoir was sometimes deficient in dissolved oxygen, but with adequate aeration was satisfactory for rearing fingerling chinook and silver salmon and rainbow and cutthroat trout. When the water was too warm for satisfactory incubation of salmon eggs, cooling to below 55° F. made it suitable. Fingerling salmon and trout reared in water whose temperature exceeded 65° F. for extended periods contracted columnaris, which was partially controlled with sulfamerazine. (A)

236. Cating, James P. 1954. DETERMINING AGE OF ATLANTIC SHAD FROM THEIR SCALES. U. S. Fish and Wildlife Service Fishery Bulletin No. 85, Vol. 54, 12 pgs.

Determining the age of shad (Alosa sapidissima)

from scales has been considered difficult by many workers, and recent investigators have attempted to ascertain only the number of times of spawning. Much of the difficulty in reading scales arises in locating the first three annuli because accessory rings, or false annuli, sometimes are found in this area of the scale, and the annuli are not always clearly defined.

A method of locating these annuli, using transverse-groove counts, is presented. After the positions of the first three annuli are known, the age of the fish can be determined by counting any additional annuli which usually are easy to see, and adding the number of spawning marks. Criteria for determining whether annuli have been obliterated by spawning marks and the number of times the fish has spawned when one spawning mark has eroded into another are also presented. (A)

237. Hile, Ralph. 1954. FLUCTUATIONS IN GROWTH AND YEAR-CLASS STRENGTH OF THE WALLEYE IN SAGINAW BAY. U. S. Fish and Wildlife Service Fishery Bulletin No. 91, Vol. 56, 52 pgs.

The annual commercial take of Saginaw Bay walleyes averaged 1,149,000 pounds in 1891-1919, 652,000 pounds in 1920-31, 1,466,000 pounds in 1932-43, and only 396,000 pounds in 1944-51. The catch was under 100,000 pounds in each of the years 1949-51. Overfishing does not appear to have been a significant factor in the collapse of the fishery; many fishermen attribute the decline to pollution.

Age was determined for 3,652 fish and growth calculated for 2,427 specimens collected in 1926-30 and 1943. The average age (number of annuli) and the dominant age group at various seasons in 1926-30 were as follows: Spawning season—7.60 years, VII group; late spring—3.90 years, IV group; fall—1.28 years, I group. The percentage of legal fish (minimum total length, 15 1/2 inches) in the catch of commercial impounding nets ranged from as high as 100 in the 1929 spawning season to as low as 1 in the fall in 1926 and 1928. The late-spawning-run sample of 1943 averaged 4.06 years old, was dominated by the III group, and included 96 percent legal-sized walleyes.

The strength of the year classes was well above average in 1919, 1925, 1937, and 1940, and weaker than average in 1917, 1924, 1928, 1938, and 1941.

Females were larger than males in all but the first 2 years of life, and walleyes of the 1943 collection had grown much more rapidly than fish captured in 1926-30. Times of attainment of legal length of 15 1/2 inches (corresponding weight 1.12 pounds) were as follows: 1926-30 fish—males, early in fifth growing season and females in latter part of fourth; 1943 fish—males near the end and females past the middle of the third season. Calculated lengths and weights for latest years of life for which data were available were for 1926-30 males—14 years, 21.3 inches, 3.05 pounds; 1926-30 females—15 years, 25.0 inches, 4.91 pounds; 1943 males—10 years, 23.3 inches, 4.00 pounds; 1943 females—13 years, 29.5 inches, 8.14 pounds. Annual fluctuations in growth showed an irregular but pronounced downward trend in 1916-29. The growth advantage of the 1943 over the 1926-30 specimens was established in the early and middle 1930's.

The weight of walleyes in the combined samples from Saginaw Bay increased as the 2.989 power of the length. Walleyes taken in the fall were heavier than fish taken in late spring. Pronounced short-term fluctuations in weight during the late spring indicated heterogeneity of the stock with respect to the length-weight relation at that season. Sound walleyes were from 5 1/2 to 6 1/2 percent heavier than fish infected with Lymphocystis.

The percentage of males was higher in the younger than in the older age groups and during the spawning run than in late spring. A higher rate of exploitation for males than for females was suggested as a major cause of the change of the sex ratio with increase in age. Lengths at which 50 percent of the walleyes had reached maturity were about 15 1/2 inches for males and 17 inches for females. (A)

238. Dimick, John B. 1954. THE DIAMOND LAKE STORY. Oregon State Game Comm. Bulletin Vol. IX, No. 12, December, pp. 3-8.

Diamond Lake is a 2,982-acre lake in Douglas County in the Umpqua National Forest. It provided excellent trout fishing until the Klamath Lake roach or chub (Siphateles bicolor bicolor) was introduced and overran the lake. Trout food studies indicated 292 pounds per acre of bottom organisms in 1946. In 1951, similar sampling produced 2.3 pounds per acre. In 1953, the catch of trout was 2.8 fish per acre. The average size of the fish dropped from 15.75 inches in 1946 to 9.6 inches in 1953.

On September 21, 1954, following lowering of the lake level as far as possible, the lake was treated with rotenone. One hundred tons of cube root were used, plus 275 gallons of emulsifiable rotenone for treating the tributary streams.

It was estimated that not over 100 rainbow trout were accounted for. It was calculated that 32,000,000 roach were killed with a conservative estimate of weight at 400 tons.

In the spring of 1955 the lake will be stocked with Kamloops rainbow trout.

239. Campbell, D. E. 1954. FISH MANAGEMENT UNIT RECORDS TWO NEW FISHES FOR PENNSYLVANIA WATERS. Pennsylvania Angler, Vol. 23, No. 2, February, pp. 2.

During the summer of 1953 two new species—the alewife (Pomolobus pseudoharengus) and the Great Lakes cisco (Leucichthys artedi artedi) were captured. The alewife was found in Little Elk Lake, Susquehanna County, and the cisco in Lake Wallenpaupack, Pike County.

240. Trembley, Gordon L. 1954. FISHING RESULTS ON UPPER WOODS POND. Pennsylvania Angler, Vol. 23, No. 3, March, pp. 2-5,23.

Upper Woods Pond offered the possibility of a complete creel census. A survey had shown it capable of supporting trout although it had a population of slow-growing warm-water species. It was

stocked with 6,000 trout—2,000 each of rainbow, brook and brown trout.

Of the trout stocked, 48 percent of the rainbow, 38 percent of the brook, and 35 percent of the brown trout were caught. Between April 15 and May 15, 62 percent of the total trout catch was taken. Rainbow trout gave the best sustained yield. Trout made up 56 percent of the total catch from the lake. Forty-nine percent of those checked were successful. The catch per hour was 0.33 fish, with the average fishing day of 4.78 hours.

241. Gordon, George H. 1954. THE PYMATUNING STORY. Pennsylvania Angler, Vol. 23, No. 5, May, pp. 2-3,21.

Pymatuning Lake is cooperatively managed by the Ohio Department of Natural Resources and the Pennsylvania Fish Commission. After several years of cooperative management it was believed that a proper harvest of fish could better be served by an earlier opening of the walleye season. This was established on May 30, one month earlier than before. A creel census was run with the following results: 3,503 fishermen fished for 19,383 hours with 0.187 fish caught per angler. White crappie made up 56.4 percent of the catch, walleyes were second with 16.1 percent. From all evidence that could be gathered, the early opening had little effect on the bass population in the lake.

242. Hublou, Wallace F., James W. Wood and Ernest R. Jeffries. 1954. THE TOXICITY OF ZINC OR CADMIUM FOR CHINOOK SALMON. Oreg. Fish Commission Research Briefs, Vol. 5, No. 1, March, pp. 8-14.

Early in January 1951, a heavy mortality occurred at the Marion Forks hatchery on the Santiam River among fall chinook salmon fry which had been transferred from the Bonneville hatchery on the Columbia River as "eyed" eggs.

Because the fry were put in new, unpainted trays made with galvanized screen, and unpainted galvanized baffle plates were used, it was suspected that the zinc and cadmium used in the galvanizing process were affecting the fish. Water samples were collected from the lower and upper ends of the troughs and analyses were made for zinc and cadmium content, pH, and the oxygen content.

The death of the fry appeared to have been caused by suffocation. This suffocation was probably caused by the action of the zinc and possibly cadmium on the gills of the fish. A precipitate either covering the filaments or plugging the interlamellar spaces of the gills made it impossible for the fish to maintain adequate circulation, and caused the fish to die. In comparing the amount of zinc in the water samples with the amount of zinc in the fish samples it appears that there is no appreciable relationship between the amount of zinc in the water and the amount of zinc contained within the bodies of the fish. This would indicate that the cause of death is something other than the absorption of the zinc salts into the body of the fish.

The painting of the tray screens and baffle plates kept the water from reacting with the galvanized coating. The mortality for troughs A and B was kept to a minimum and no symptoms similar to those in trough C were noted.

The fish in trough C were subjected to concentrations of 0.150 p.p.m. zinc, compared with 0.034 p.p.m. for trough A and 0.037 for trough B. There was little difference in the concentration of cadmium among the three troughs. If zinc or cadmium was the cause of death it would appear that some fish were able to tolerate the concentrations encountered longer than others.

There was a 26.7 percent mortality for trough C fish from November 11, 1951, through April 8, 1952, which was over five times the percentage loss of either trough A or B for the same period. The mortality for trough C would have been much higher had it not been necessary to remove the fry from the trays on February 3, 1952, because the accumulation of debris in the empty trays stopped water circulation in the trough.

The oxygen content of the water and the pH were both considered to be normal and did not enter into the toxic effect caused by the zinc and cadmium.

243. Willis, Raymond A. 1954. THE LENGTH OF TIME THAT SILVER SALMON SPENT BEFORE DEATH ON THE SPAWNING GROUNDS AT SPRING CREEK, WILSON RIVER, IN 1951-52. Oreg. Fish Commission Research Briefs, Vol. 5, No. 1, March, pp. 27-31.

Two hundred of 202 silver salmon spawning adults were tagged as they entered Spring Creek in the winter of 1951-52. Those captured at the weir were jaw tagged with stainless steel bands around the dentary; those captured below the weir were tagged just under the dorsal fin with Petersen type plastic disks.

The average length of time the spawners spent in Spring Creek until death was about 11 days for females, 12 days for males over 20 inches in length, and 15 days for males 20 inches and under in length. Jack silver salmon were alive in the stream a maximum of about 57 days and a minimum of about 3 days.

The regressions of the number of days in the stream until the recovery of dead fish, on the weekly tagging dates were significant for both the females and males over 20 inches in length. This indicates that the early arrivals to the tributary remain alive longer than do the later arrivals. (A)

244. Jeffries, Ernest R., Thomas B. McKee, Russell O. Sinnhuber, Duncan K. Law, and T. C. Yu. 1954. THIRD PROGRESS REPORT ON SPRING CHINOOK SALMON DIET EXPERIMENTS. Oreg. Fish Commission Research Briefs, Vol. 5, No. 1, March, pp. 32-38.

Because it is becoming more difficult to provide adequate food for fish hatcheries, the Fish Commission of Oregon and the Oregon Agricultural Experiment Station Seafoods Laboratory are cooperating in a series of experiments designed to develop satisfactory beef liver substitutes, test present hatchery food components, and appraise potential hatchery food components.

This present study describes a further modification of the Wisconsin diet used to evaluate both actual and potential hatchery food components. This study also compares Argentine beef liver meal and two other beef liver substitutes (air-dried grasshopper meal and condensed sardine solubles) with fresh-frozen beef liver when each is used as a supplement to the further-modified Wisconsin diet.

A modification of the Wisconsin diet, designated as the Oregon diet, will support growth of spring chinook salmon fingerlings.

Fresh-frozen beef liver appears to contain a factor or factors which promote growth in chinook salmon fingerlings. It is probable that this factor is affected adversely by heat since the drum-dried beef liver gave a lesser growth response than the fresh-frozen beef liver. Supplementation of the Oregon diet with Argentine beef liver meal gave no additional growth perhaps because commercially prepared liver meals are normally subjected to high-temperature drying methods.

Condensed sardine solubles and air-dried grasshoppers give a growth response similar to that of drum-dried beef liver.

When combined with 10 percent beef liver, turbot and hake meals are an excellent source of protein for use in feeding spring chinook salmon fingerlings. It is likely that the factor or factors that promote rapid growth are also present in turbot and hake.

The essential material responsible for rapid growth is different from any of the commonly described vitamins including vitamin B_{12} and procaine penicillin.

245. Jenkins, Robert M. and Gordon Hall. 1954. GROWTH OF LARGEMOUTH BASS IN OKLAHOMA. Okla. Game and Fish News, Vol. 10, No. 1, Jan., pp. 3-5.

To arrive at an average growth-rate for Oklahoma largemouth bass 4,060 specimens from 152 bodies of water were used.

Oldest bass of the 4,060 study specimens was eight years. Ninety-five percent were less than six years old.

The average Oklahoma largemouth bass measure about 5.5 inches at the end of their first year of life, and during successive years reach average lengths of 9.7, 12.5, 14.9, 17.1, 18.6, 19.9, 20.9 and 22.6 inches. The corresponding average weights for bass at these lengths are approximately 0.07, 0.4, 1.0, 1.8, 2.8, 3.6, 4.5, 5.3 and 6.8 pounds, respectively.

246. Raney, Edward C. 1954. THE STRIPED BASS IN NEW YORK WATERS. New York State Cons., Vol. 8, No. 4, Feb.-March, pp. 14-16.

This article describes the work being done by the State on the striped bass and gives information on life history such as migration, spawning, age and growth, and food.

247. Greene, C. W. 1954. A NEW FISHERIES SURVEY. New York State Cons., Vol. 9, No. 1, Aug.-Sept., pp. 18-19.

New York is planning to resurvey some of the areas covered in their intensive survey of watersheds from 1926-1939. As each new area is covered, a review of the fishery management policies will be undertaken and necessary revisions made.

248. Greeley, John R. 1954. SALMON IN NEW YORK. New York State Cons., Vol. 8, No. 5, April-May, pp. 8-9.

New York has two salmon species at present—the landlocked Atlantic salmon and the landlocked variety of the sockeye salmon commonly known as the kokanee.

New York fishermen are familiar with the capture of the Atlantic salmon, but less so with the kokanee. Methods for taking kokanee are given. It is still too early to predict what future the kokanee may have in New York lakes, but if the supply can be built up, the red salmon may become fully established as a light-tackle sport fish for small, deep lakes. This species is not protected by law in New York and may be angled for at any time, any size.

249. Talbot, G. B. 1954. SHAD IN THE HUDSON. New York State Cons., Vol. 8, No. 5, April-May, pp. 17-19.

Every year around the last week in March an old industry begins anew in one of the biggest and busiest harbors of the world. This is the Hudson River shad fishery. Each spring, beginning in the lower Hudson against a back-drop of New York City's skyscrapers and continuing upriver to the vicinity of the City of Hudson, shad fishermen undertake to harvest this delectable fish in the same manner they have followed for some 300 years.

Shad are the largest members of the Clupeidae or herring family in the United States and must ascend streams into fresh water to spawn. They congregate near the mouths of rivers each year to make the spawning run. The time of run depends upon the latitude; i.e., the prevailing temperatures. In the St. Johns River in Florida, for instance, the migration begins as early as November and reaches its peak in December or January. Farther north in the Carolinas the run reaches its peak in February or March, while in the Hudson River the bulk of the fish arrives in April. The range of this fish extends as far north as the St. Lawrence River in Canada, where the run occurs in June.

During the month of May when the water warms to above 50° F. shad begin to spawn. This activity takes place in the river principally between the cities of Hudson and Kingston. The eggs are broadcast loosely in the water by the roe shad and are fertilized by a buck swimming near her. After absorbing water the eggs are about 1/8 of an inch in diameter and are slightly heavier than water. They gradually settle to the river bottom where they are carried back and forth with the tide which affects the Hudson River as far up as the dam at Troy. The eggs hatch in 5 or 6 days and the young shad spend their first summer in the river. In

the fall during October and November when the water begins to cool, the young shad move down the river to the sea, where they remain for the 4 to 5 years required to attain maturity.

Among the fishermen each year the big question is: "How will the shad run this year?" This is a good question, for the catch has fluctuated widely during the last 39 years during which good statistics have been kept. Even before 1915 there are records of "good" and "bad" years. For instance, Hudson River catches exceeding 4 million pounds between 1885 and 1890 are recorded. Then, in spite of the help of a shad hatchery with a production of 4 million to 17 million shad fry each year, the run began to drop off. By 1916 only 40,000 pounds were caught. The catch increased somewhat in the years following but remained fairly low until 1936 when the catch increased tremendously, and for the next ten years annual catches of around 3 million pounds were made.

After 1946, however, the runs of shad decreased again, and because the shad runs along the entire Atlantic Coast had also diminished, the Atlantic States Marine Fisheries Commission sponsored a coastwise study of this fish to determine methods of increasing and stabilizing the catch. This research project was begun in 1950 on the Hudson River by the U. S. Fish and Wildlife Service in cooperation with the New Jersey and New York Departments of Conservation.

The conclusion reached in this study, assuming that size of spawning population does control population size, is that this fishery can be stabilized at a high productive level by allowing the optimum number of shad to escape the fishery each year to spawn. This can be achieved by regulating the commercial fishery by closing the waters to fishing for appropriate periods each week. This should work no hardship on the fishermen, for this is truly a case of being able to eat your cake and have it too—those shad which are not caught, but allowed to spawn, produce fish which return to the river predominantly 4 and 5 years later, and they themselves return to the river the following year as bigger and better fish ready to be captured.

250. Zilliox, Robert G. 1954. TROUT RESTORATION PROGRAM. N. Y. State Conservationist, Vol. 8, No. 5, April-May, pp. 22-23.

The Adirondack Trout Restoration project is an experimental program designed to reclaim former trout waters that are now inhabited by undesirable introduced species of fish.

To date, a total of 30 ponds have been reclaimed under this program and six additional ponds have been treated under Dingell-Johnson Project F-5-R.

One of the most important aspects of any reclamation program is the construction of barrier dams to prevent undesirable species of fish from reinvading waters treated. Growth and survival of brook trout, which have been stocked in various sizes and ages, have been found to be above average in reclaimed ponds.

To further our knowledge of what takes place in these waters after reclamation, a partial creel census has been conducted. On 50-acre Mountain Pond, during the census period in 1952, 1,074 anglers caught 733 trout representing a yield of three pounds per acre, while in 1953, 1,556 anglers caught 1,006 trout with a yield of five pounds per acre. It is planned to vary the stocking rate in this pond, to see its effect upon the number of fish and the yield per acre to the angler.

If a complete kill of introduced species such as perch, bass, pickerel or northern pike is not effected, trout fishing can generally be expected to deteriorate within five years. While this might be considered feasible management in areas with little or no brook trout fishing, it is not too practical a procedure in the Adirondacks, and all methods and efforts should be applied towards obtaining a complete kill.

251. Lawrence, W. Mason. 1954. SIZE LIMITS ON TROUT. N. Y. State Conservationist, Vol. 8, No. 5, April-May, pp. 24-25.

This article reviews the background for establishing the size limits on brook trout in New York State.

252. Horst, John. 1954. OHIO'S NEWEST FISH MANAGEMENT TOOL. Ohio Conservation Bulletin, Vol. 18, No. 2, February, pp. 16-17.

The Division of Wildlife's Fish Management Section, with the cooperation and supervision of the Engineering Section, has branched out into new fields—locating depth contours on Ohio's lakes, when ice-free, by means of the "Subscout".

The "Subscout" is a depth measuring instrument. Working on the principle of the aneroid barometer, it gives instantaneous readings at any depth up to fifty feet with fair accuracy (about 39 feet in 40 feet). Three elements comprise the "Subscout": the indicator, the cable, and the sensing unit. The entire depth finder is air-tight. The sensing unit is fastened to a row boat which is propelled by a motor. This copper pipe is dragged along the bottom of the lake. Different depth pressures are transmitted to the indicator unit through the cable.

253. Dambach, Charles A. 1954. WHY WE HAVE LIBERALIZED FISHING. Ohio Conservation Bulletin, Vol. 18, No. 4, April, pp. 4-5.

Ohio's "liberalized fishing" program has been the subject of much discussion in conservation circles both within and without the State. In effect, the foundations for Ohio's "liberalized fishing" program was laid by the General Assembly of 1873 which created an Ohio Fish Commission and directed it to "examine the various rivers, lakes, ponds and streams of the State of Ohio with a view of ascertaining whether they can be rendered more productive of fish and what measures are desirable to effect this object." The Commission initiated a sound program of lake and stream surveys which have been continued with appropriate revisions on an ever increasing scale up to the present time. In its early reports, concern was expressed that unless protection to fishes during spawning was afforded there were "substantial grounds for be-

lieving the total extinction of fish life in Ohio is drawing near."

Recommendations for closed seasons for various bag and length limits were subsequently adopted. Fish farms numbering more than a dozen were established and hundreds of millions of fish from fry to adults were stocked. During all these changes the work of the fisheries investigators continued unabated. Bit by bit, year by year, the evidence piled up.

Ohio fisheries scientists were not the only ones to become sensitive to these facts. Others noted it too, and some were bold enough to say so in technical meetings and in scientific publications. Finally in 1945 the overwhelming weight of the evidence prompted the state fisheries men to ask the Wildlife Council for authority to put the role of restrictions in fisheries management to the supreme test in a few experimental waters. The Council, by then empowered by the Legislature with authority to establish fishing regulations responded by authorizing an experimental program to determine the effect of regulations on fish populations and fishing success.

By 1952 all of the lakes in the State were opened to liberalized fishing by angling and the same year all of the streams were added. In the spring of 1953, the removal of rough fish by nearly any method but shooting, poisoning or dynamiting was permitted. Each of these actions was based upon the expressed wish of duly elected farmer and sportsmen representatives at county, district and state public hearings and findings of highly qualified fisheries biologists.

These actions have made possible millions of hours of worry-free fishing pleasure for the citizens of Ohio. There is no evidence to date that it has in any way hurt fishing of any kind for any species. Nor is there any evidence that it has in any way resulted in reducing numbers of stunted fishes in overpopulated waters sufficient to improve the quality of fishing. There is abundant proof that it has increased fishing opportunity many fold—particularly for the amateur fisherman, the man with the cane pole and a can of worms who looks to fishing as a way of enjoying the out-of-doors with his family.

254. Chapman, Charles R. 1954. SANDUSKY BAY CREEL CENSUS. Ohio Conservation Bulletin, Vol. 18, No. 12, December, pp. 9, 31.

The creel census program which has been carried on in Sandusky Bay over the past year shows that fishing compares favorably in terms of fish caught per hour of angling with creel census statistics from Minnesota, Michigan, Canada and other areas considered to have good fishing.

Creel census has been conducted a minimum of two half-days each week when fishing pressure was low and three full-days when fishing pressure was high. A count of the total number of fishermen on the bay was also conducted.

During the 12-month period, 7,013 fishermen were interviewed on Sandusky Bay. Fishermen for the period averaged 0.93 fish per hour which is considered good fishing. Twenty three species of fish were caught during this period however, the following eight species were the more important fish caught by numbers in Sandusky Bay: yellow perch, white bass, white crappie, black crappie, channel catfish, bullheads, sheepshead, and carp.

It was found that fishing was fair during the summer and success rapidly increased during the fall and into the winter. A sharp drop in success was recorded in January followed by an increase in February and March. A decline followed in April and May with a rise in success shown in June.

Ice fishing contributes the largest catches of fish in Sandusky Bay with average catches per hour by angling of 3.99 fish recorded in December. Fish caught during this period are almost exclusively yellow perch with an occasional crappie or northern pike.

A table shows additional information obtained during the creel census interviews. This consists of the best fishing method for each species, the best season to fish for each major species caught in the Bay, the time of day producing the best catches, the baits producing the best catches, the average length of each species of fish caught and the spawning time of each species.

255. Simpson, James C. 1954. WHY NOT INTRODUCE NEW SPECIES OF FISH? Idaho Wildlife Review, Vol. 7, No. 3, Nov.-Dec., pp. 4-5,11.

The results of introduction of 27 species of fish into Idaho waters are discussed in the article. In a few instances the introductions have aided sport fishing, but by and large the elimination of many of the introduced species would improve sport fishing. Caution in introductions is urged.

256. Cook, Fannye A. 1954. BAIT MINNOWS—THEIR PROPAGATION IS A NECESSITY. Miss. Game and Fish, Vol. 18, No. 2, Sept., pp. 3-5.

This article describes the species recommended for bait culture in Mississippi.

257. Evans, Robert L. 1954. HEALING THE SICK: NEFF LAKE. Colo. Conservation, Vol. 3, No. 1, Jan.-Feb., pp. 27-30.

Neff Lake was a sick lake, both physically and biologically, in 1952. There were no aquatic plants to furnish shade and cover for the equally sick fish. It was muddy and few microscopic organisms could be found in the water. However, the lake was "home" to thousands of carp which could be seen milling about in the shallows with their backs partially exposed.

Attempts to seine the lake were unsuccessful, so it was chemically treated in September 1952. Nearly a complete kill was obtained, and as soon as the lake was safe for fish it was restocked during the fall of 1952 with over 30,000 fish, including black and white crappie, black bass, channel catfish, minnows and bluegill. Over 75,000 more fish were planted in 1953, including rainbow trout and walleyed pike in addition to species mentioned above.

Brush shelters were built and sunk through holes cut in the ice. The food supply was increased by planting gunny sacks of barnyard manure in each

shelter with two hundred pounds of commercial meat scraps to increase the fertility of the water in that vicinity. Five wash tubs of filamentous algae and other aquatic plants containing large numbers of scuds, snails and aquatic insects were dumped in the shelters. A large number of forage fish were stocked to furnish food for the other fish.

The lake was closed to all fishing during the 1953 season. Neff Lake recovered rapidly. In May of 1953, aquatic plants such as green algae and pond weeds began to grow. The water became extremely clear and the bottom of the lake could be seen in 15 feet of water. By July, the lake bottom was covered with aquatic plants and the brush shelters were partially covered with filamentous algae.

The fish made excellent growth in 1953. The black bass averaged 5 inches in May and then grew an inch a month until the latter part of September at which time the bass were nearly 10 inches long and weighed a third of a pound. The rainbow trout which averaged 3 inches in length in March were 10 1/2 inches long in November and weighed over half a pound. The bluegill fry which were less than an inch long in November 1952 were 6 inches long and weighed a quarter of a pound one year later.

258. Taliaferro, Rex and Don Nolting. 1954. CREEL CENSUS AT JUMBO RESERVOIR. Colorado Conservation, Vol. 3, No. 3, May-June, pp. 20-22.

A creel census was conducted in 1952 and 1953 as a part of the fishery research program carried on at Jumbo Reservoir by the Colorado Game and Fish Department. Major game fish species present in the waters include yellow perch, black crappie, white crappie, rainbow trout, channel and bullhead catfish.

During the 1952 creel census, roughly 75 percent (1,241) of all the fishermen were interviewed, and over 50 percent (1,582) in 1953. The over-all fishing success closely approached the cpmh rate of 1.0 in 1952 and exceeded this figure in 1953. Still fishing, using minnows for bait, was generally the most successful technique.

The yellow perch made up 89 percent of the total catch during 1952 and 193 percent during 1953. These These fish averaged 7 inches long in 1952 and 7 1/2 inches in 1953. Perch up to 14 inches in length were caught.

During the two years, the crappie composed less than two percent of the total catch. However, in 1952 their average size was about 13 1/2 inches. A group of smaller crappie appeared in the catch during 1953 and lowered the average length of these fish to just under 11 inches.

Bullheads made up three percent of the catch in 1952 and increased to five percent in 1953. During the 2-year study, bullheads averaged about 8 inches in length. Very few fishermen at Jumbo employed techniques necessary for taking channel catfish and the catch was low.

In 1952 and 1953, a total of 320,276 rainbows were stocked. About 10 percent of these fish were of catchable size when stocked; however, the majority were fingerlings. Only 0.2 percent of the trout were taken by the fishermen during the 2-year period.

259. Klein, W. D. 1954. WHO'S A FISH HOG? Colorado Conservation, Vol. 3, No. 2, pp. 14-15, March-April.

The law enforcement division of the Colorado Game and Fish Department has been contacting and recording the catch of resident and non-resident fishermen throughout the State for a number of years—some 25,000 checks each year. By averaging the results of these checks for the period 1948 through 1952 it was found that the out-of-State fisherman's take amounts to only 6.3 percent of the total catch.

Information obtained by the fish research section in Federal Aid studies on two eastern slope lakes gave an opportunity to analyze the trout catch by various categories of resident fishermen in considerable detail, and to make comparisons with the resident and non-resident catch percentages obtained from warden contacts. Compilation of this data showed that resident men fishermen catch 82 percent of the trout caught by Coloradans at Parvin Lake and Skaquay Reservoir. The catch by boys and girls (fishermen under 16 years of age) was relatively unimportant (6 percent). The ladies' take was 12 percent and their catch per man-hour was 0.5 as compared with the men's catch of 0.71 per man-hour.

The non-resident fishermen pay substantially for the trout they catch. Taking a 5-year average, 1948 through 1952, license sales to out-of-state fishermen made up 21 percent of the total fishing license sales, and accounted for 30 percent of the revenue from the sale of fishing licenses. According to all the information available, non-resident fishermen usage of the trout fishery amounted to less than 10 percent of the total, and was responsible for removing less than 7 percent of the total trout catch.

260. Westman, James R. and Rose F. Nigrelli. 1954. PRELIMINARY STUDIES OF MENHADEN AND THEIR MASS MORTALITIES IN LONG ISLAND AND NEW JERSEY WATERS. New Jersey Outdoors, Vol. 5, No. 3, September, pp. 12-17, 21.

Federal statistics indicate that the menhaden fishery is presently the largest fishery, by weight, in the United States. Some 800,000,000 pounds are harvested during a good year from our Atlantic and Gulf Coasts. Neither a food nor a game fish, the menhaden—or pogy, mossbunker, 'bunker, or fat back, as it is often called—is processed into fish meal, scrap, and oil, which in turn enter a host of products utilized by man. In addition, thousands of tons of ground-up mossbunker are thrown into the water as chum for bluefish, tuna and albacore each year by the saltwater anglers of New York and New Jersey.

Menhaden appear in the New York bight in commercial quantities during late March or April. During the latter part of May, or early June, great quantities of menhaden die in these waters and in the waters of western Long Island Sound, and litter the beaches in untold numbers.

A program of investigation was started by the New York Conservation Department during 1948, and has been continued by the State University of

New Jersey, in collaboration with the New York Zoological Society, since 1949.

It was discovered that the scale samples from most of the menhaden could be read with some difficulty.

First runs of fish, prior to 1953, were, upon the basis of scale analysis, composed almost entirely of three and four-year-old menhaden. Two-year-old menhaden entered the commercial catches in large numbers some weeks later. Young-of-the-year appeared in estuaries, tidal rivers and creeks, and mooring basins and canals during June, and appeared to remain in these situations until late September or October. Unlike the adult population, the young-of-the-year exhibit no aversion to fresh water. They have been found in numbers as far up the Hudson River as Newburg; in the Peconic River and Riverhead, Long Island; and in the Maurice River at Millville, New Jersey.

All menhaden of three years of age, or more, appear to be adult fish.

The annual heavy mortality in the waters adjacent to New York Harbor occurs in late May and June when millions of fish die and litter the beaches. Dying fish, called "spinners," are characterized by a loss of coordinated movements and exopthalmia of one or both eyes. Hemorrhages, caused by gas emboli, were noted in the capillaries of the gills, eyes, and optic lobes of the brain. The culture tests of the scales and the feeding of stomachs and intestines to experimental cats, yielded negative results.

Whether the gas emboli noted above are a terminal cause of death, or merely represent an associate condition, is a matter of conjecture.

Analyses of the waters in which these annual mortalities occur show two conditions that might be associated with the phenomenon: (1) markedly varying salinities, and (2) organic pollution to a degree where shellfishing is prohibited.

261. Smith, Roland F. 1954. CONTROL OF TURTLES. New Jersey Outdoors, Vol. 4, No. 10, May, pp. 14-16.

It is often desirable to control turtles in lakes and streams because of their extensive damage to ducklings.

Types of control mentioned are:

Shooting: The head of a turtle offers a small target, yet hunting turtles with a gun can be excellent sport. Unless undertaken in a very extensive manner, however, this type of control is hardly significant.

Trapping: Several types of traps have been designed to effectively capture turtles. (1) Hoop net—this consists of a netting, either wire or cotton, constructed around a series of hoop frames. The net is baited with any type of meat scraps and set in a stream or along the shallows of a lake in areas that turtles are known to frequent. The meshes of this trap should be no less than 1 1/2 inches in diameter, and larger if possible. This will prevent the capture of most of the sunfishes and perch. (2) Fyke net—This type of trap is essentially similar to the hoop net except that wings are constructed to extend obliquely, at a 45° angle, from each side of both entrances. The fyke net may be set in either lakes or streams. Both the hoop and fyke net should be set parallel to the shore line for best results.

Set Lines: This type of control also affords a limited amount of sport. It is particularly effective where turtles are numerous. There are two types of set lines commonly in use: trot lines and jug fishing. Jug fishing merely requires several "jugs" (gallon bottles or tin containers painted with a bright color) and short lengths of fishing lines. The lines are baited and thrown overboard. The angler watches from a point of vantage for one of the jugs to bob. Red meat with lots of grizzle, or bone, is good bait. Chicken heads have been found to work very well.

262. Byrd, I. B. 1954. FISH NETTING REPORT. Alabama Conservation, Vol. 25, No. 5, May-June, pp. 4-5, 24.

Intensive studies to determine the effects of commercial fishing with 1 1/4 to 1 1/2-inch bar trammel nets in the tidal streams of Mobile and Baldwin Counties of South Alabama were conducted during the period from January 1954 through March 1954. Preliminary studies were conducted during the months of November and December 1953.

These studies were initiated after commercial fishermen requested that they be allowed to fish tidal streams with small mesh trammel nets.

Streams studied included Dog, East Fowl, West Fowl and Little Rivers in Mobile County; and Fish River, Bon Secour River, Magnolia River, Hammock Creek, Palmetto Creek, Soldier Creek, Wolf Creek, Graham Creek and Graham Bayou in Baldwin County.

Both day and night studies were conducted during January, February and March. Beach, circle and snake sets with and without topnets were made at various depths.

A total of 47,166 fish, turtles and crabs were netted during the period of the experiments which weighed 38,471.16 pounds. Mullet, gar, blue catfish, shad, suckers and buffalo made up 96.56 percent of the total weight. All fresh water game fish netted constituted 0.57 percent of the total weight while speckled trout made up 1.16 percent of the total weight. The remaining 1.71 percent of the weight was made up of various species of commercial and rough or unusable fish, turtles, and crabs.

There appeared to be no significant difference between the percentages of the weights of commercial and fresh water game fish taken during the day or night experiments.

Fresh water game fish constituted 0.67 percent of the night catch and 1.24 percent of the day catch while speckled trout made up 1.33 and 0.82 percent of the night and day catches, respectively.

Since more than 98 percent of the total catch was commercial or rough species and less than 2 percent fresh water game fish and speckled trout, it appears that commercial fishing with 1 1/4 and 1 1/2-inch bar mesh trammel nets would not be of detriment to the fresh water game fish and speckled trout populations in the tidal streams. In fact, it would seem that the removal of the tremendous

poundages of commercial and competitive species of fish would actually benefit the game fish populations.

263. Andriano, Don. 1954. THE PORTNEUF RIVER CREEL CENSUS. Idaho Wildlife Review, Vol. 6, No. 6, May-June, pp. 6-7.

In 1951 a creel census was conducted in eastern Idaho on the Portneuf River between McCammon Falls and Portneuf Siding. Analysis of the data indicated that 6,040 anglers caught an average of 0.74 fish for each hour of fishing and recovered a total of 14,142 trout during the season. Of this number, 75 percent were brown trout, 14 percent rainbow, and 11 percent cutthroat.

The value of fish stocking was determined in the Portneuf River census by tagging or fin-clipping nearly all of the 12,096 brown trout which were placed in the stream. Tabulation of the data shows that an estimated 68.9 percent (8,329) of the hatchery fish were captured the same year they were stocked. These same 8,329 fish comprised 58.9 percent of all the trout caught from the stream. Had the fish not been stocked the quality of fishing would have decreased nearly 60 percent.

The stocked fish averaged 0.25 pounds per fish. The cost of producing the 12,096 hatchery fish in 1951 was $2,872.00. On the basis of 8,329 hatchery fish caught, the cost averages out at 34 cents each, or $1.36 per pound. This is a maximal figure as some of the fish may be recovered in subsequent years.

The maximum recorded upstream movement of a hatchery fish was slightly over four miles. Maximum downstream movement was less than 0.15 of a mile. Generally, the 252 hatchery fish whose movements were traced did not travel a great distance from the stocking site. About 35 percent of the fish had moved less than 50 yards at the time of capture, and 64 percent moved less than 300 yards from where they were planted in the stream. Movement was generally upstream rather than downstream.

Three factors which appeared to affect the movement of the hatchery fish were: (1) Suitability of the planting site. (2) Length of time the fish remained in the stream prior to capture. (3) The method used to mark the fish for future identification.

The differential in the movement between tagged and clipped fish was not expected. For undetermined reasons, the tagged fish traveled on the average of over one-third a distance greater than the clipped fish. The 70 tagged fish each traveled a mean distance of 978 yards, while the 182 fin-clipped fish moved only an average of 598 yards prior to capture.

264. Funk, John L. 1954. GIGGING—FOR AND AG'IN'. Missouri Conservationist, Vol. 15, No. 11, Nov., pp. 1-3.

Gigging is a highly controversial subject, as reflected in the changing regulations. In the 10 years between 1940 and 1950, 17 important changes were made in gigging regulations in Missouri. Gigging is confined almost entirely to the Ozarks. Here the most popular game fish is the smallmouth bass and the most abundant rough fish is the redhorse sucker. The problem boils down to the abundance of the smallmouth bass and redhorses in the Ozark streams and how gigging affects them both.

In the Ozark streams, redhorse suckers are always abundant. They often make up 40 or 50 percent of the larger fish in a stream, and average about 25 percent. The smallmouth bass seldom makes up as much as 15 percent, and on the average, not much over 5 percent.

Missouri fisherman's catch for the past several years by means of a statewide general creel census showed that hook and line fishing in Ozark Highland area resulted as follows:

	1950	1951	1952
Fish per hour	0.59	0.75	0.67
Fish per man	1.8	2.5	2.2
Percent of bass	15	17	16
Percent of suckers	10	7	10

Gigging in the same area for the same periods resulted as follows:

	1950	1951	1952
Fish per hour	2.14	1.55	2.12
Fish per man	6.0	5.8	6.2
Percent of suckers	87	85	83

From these figures it can be seen that gigging has not had any appreciable effect on hook and line fishing in the Ozarks. Also, it is evident that gigging is about three times as efficient as hook and line fishing.

If further regulations of gigging are to be established for Missouri, it will be necessary to conduct more extensive creel and population censuses and determine many other factors such as food habits of the suckers, illegal take, etc.

265. Burner, Charles. 1954. REPORT ON PROGRESS OF FISH MANAGEMENT STUDIES ON STRIP-MINE LAKES. Kansas Fish and Game, Vol. 11, No. 3, Jan., pp. 5-8.

In recent years the increasing number of fishermen with the resulting increase in fishing pressure has made it necessary to explore all possibilities for developing fish populations to meet this increased demand on ponds, lakes and streams of the State of Kansas. The Kansas Forestry, Fish and Game Commission is studying conditions in strip-mine lakes of southeastern Kansas, in order that they may arrive at some course for improving the fishing success in these waters so as to help meet this increased fishing pressure, and to provide more good fishing waters for the public.

Results of the 1949 survey indicated that about 20 percent of the strip-mine lakes have water that has a low pH (degree of alkalinity or acidity) and is therefore too acid for good fish habitat. Many more lakes are so small or inaccessible that they cannot be considered of much value as potential fishing water. That still leaves quite a large number of strip-mine lakes varying from one-half acre to more than 30 acres in area which can support a good fish population and which are of interest to the angler.

The older strip-lakes seem to go through much the same cycle as other lakes in the State; that is,

the bluegill gradually gets the upper hand and becomes stunted, crowding out the bass. A few years after the pits are stocked, they seem to show their best fishing, then gradually dwindle off, and a decline in catches is observed.

The water in strip-pits is characteristically quite transparent. Visibility in excess of 12 feet in depth has been observed in a number of instances. This factor alone is enough to almost completely eliminate chances of spawning success by crappie, channel catfish and bullheads when game fish are present. It also appears to lessen spawning success of the bass.

Strip-mine waters which were studied during the summer of 1953 and which had been restocked approximately 15 months showed that 3-inch fingerling bass had grown to 10 or more inches. Channel catfish stocked at the same time had grown to a length of 12 inches during the same period.

Management work on strip-mine lakes includes the following: (1) Total removal and subsequent restocking of fish where investigations indicate this is the best way to improve fishing success. (2) Partial eradication in a portion of a strip-pit and restocking with game fish so as to restore a balance of sunfish and bass. (3) Marginal treatment of the shallow waters to reduce the numbers of overabundant pan fishes so that the more desirable game fishes will be given an opportunity to multiply and make better growth. (4) Stocking new strip-pit waters as they fill soon after the mining operations are abandoned.

266. Lowry, Ed. 1954. HOW BIG IS A SMALLMOUTH BASS? Missouri Conservationist, Vol. 15, No. 8, August, pp. 4-6.

The following tables were set up as a result of stream censuses made every summer on Missouri streams since 1946 for the Missouri State Conservation Commission. Statewide average growth rates of 1,378 smallmouth bass in Missouri streams. (Average calculated total length in inches at indicated age)

Age	Inches	Age	Inches
1	3.2	7	16.0
2	6.9	8	16.3
3	9.9	9	16.5
4	11.8	10	16.4
5	14.1	11	16.5
6	15.4	12	17.5

Average weights per each inch of total length of smallmouth bass of some Missouri Ozark streams were as follows:

Length in inches	Avg. Wgt. lbs.	oz.	Length in inches	Avg. Wgt. lbs.	oz.
6		1.6	14	1	6.1
7		2.6	15	1	11.3
8		3.9	16	2	1.3
9		5.7	17	2	8.1
10		7.8	18	2	15.8
11		10.5	19	3	8.5
12		13.7	20	4	2.1
13	1	1.6	21	4	12.8

267. DiCostanzo, Charles. 1954. CLEAR LAKE ANGLING, 1953. Iowa Conservationist, Vol. 13, No. 6, June, pg. 43.

In 1953 the Iowa Cooperative Fisheries Research Unit conducted a survey of the summer fishing at Clear Lake. The creel census extended from June 20 to August 30, 1953, and all estimates of the total number of fish caught, angling pressure, etc., presented apply only to this period.

From the survey data it was estimated that 43,000 fishing trips were made to Clear Lake, summer 1953. Approximately 170,000 man-hours were expended in fishing and resulted in a total harvest of 179,000 fish weighing in the aggregate of about 64,000 pounds.

Clear Lake anglers were able to take fish at the rate of one fish per hour. By far the most important of the species taken was the yellow bass. An estimated 88,000 yellow bass, weighing approximately 38,000 pounds were caught between June 20 and August 30. They ran from 8 to 10 inches in length. In spite of the huge number harvested the return of fish tags from anglers indicates that but a small portion of the total population was actually removed from the lake.

Next in relative order of abundance in the catch were the bullheads, followed closely by the yellow-perch. Bullheads were represented by two size groups—6 to 8 inches and 11 to 13 inches. As was the case with the yellow bass, the large gap between the two size groups resulted from a failure of the intermediate age classes to survive. The larger group made up 16 percent of all the bullheads caught.

Since most anglers were interviewed only during daylight hours, the creel census did not give an adequate picture of the angling for channel catfish. Most of the catfish taken ranged in size from 16 to 21 inches and were caught on dead minnows fished from docks at the east end of the lake.

268. Kutkuhn, Joseph H. 1954. MID-SUMMER FISHING AT NORTH TWIN. Iowa Conservationist, Vol. 13, No. 6, June, pp. 41, 44.

During the fishery investigations at North Twin Lake, summer 1953, the food and feeding habits of the principal game species were studied during July and August. It was found that the larger yellow perch, walleyes, yellow bass or "stripers", and bullheads all relied quite heavily upon small yellow bass for the bulk of their food. Insects and crustaceans were eaten by some of these fish but there was little doubt that the small yellow bass were the principal food items.

It appears that the wider use of minnows for bait might be the key to angling success for the above-mentioned species during the hot summer months. Artificial lures that simulate small yellow bass or other fish also have proven to be very effective for catching perch, "stripers," and walleyes.

Fish for food habit studies at North Twin Lake were captured using gill nets. The nets were lifted every two hours and the fish removed for examination. By following this procedure it was possible to obtain information regarding the feeding habits and activity of fish throughout the day.

Since the number of fish captured in a gill net depends to some extent upon the degree of activity of the fish, it was found that the various fish species were more active at certain hours of the day. Furthermore, this increased activity appeared to be associated with the feeding of the fish.

Yellow perch, for example, seemed to be most active between the hours of 6 p.m. to 8 p.m. since most of them were caught during this period. The feeding activities of this species reached their peak during the period of 2 a.m. to 6 a.m., the average volume of food in their stomachs being the highest at this time.

It is interesting to note that the activity patterns of North Twin Lake perch seemed to be in direct contrast with those previously determined for perch in Clear Lake, Cerro Gordo County. Here the perch were found to be more active during the day than at night. The reason for the difference in the two lakes is not known.

Walleyes in North Twin Lake seemed to follow a feeding pattern similar to that of the perch except that they began intensive feeding slightly earlier.

Almost any time between the hours of 10 p.m. and 8 a.m. was the most productive insofar as catching yellow bass was concerned. Stomachs of bass captured during the night hours contained a greater average volume of food than those caught at other hours of the day.

Bullheads were found to feed quite regularly throughout the day. The larger specimens were most often captured at night, however, and usually were found to have been feeding on small fish. No bullhead stomachs obtained during the daylight hours contained fish.

269. Fahy, William E. 1954. THE LIFE HISTORY OF THE NORTHERN GREENSIDE DARTER, ETHEOSTOMA BLENNIOIDES BLENNIOIDES (RAF.). Jrnl. of the Elisha Mitchell Scientific Society, Vol. 70, No. 2, Dec., pp. 139-205.

A synonymy of Etheostoma blennioides is given, and specific characters are mentioned. Color descriptions and patterns are described in detail for adults and juveniles throughout the year. The general distribution for the species, and the northern subspecies, E. b. blennioides in particular, is presented. The greenside darter is found to be primarily a riffle dweller in all age-groups and in both sexes.

Locomotion is accomplished chiefly by the tail and sometimes by the pectoral fins alone. Jets of water expelled through the gill slits might be responsible for forward movement at certain times. The resting position of the greenside darter is described.

Both sexes feed throughout the year, including the spawning season. Insects form almost the entire diet.

Both sexes mature and spawn in the spring of the year following that of hatching. Sexual dimorphism in the species is most apparent in coloration and pattern.

The study indicates the number of eggs spawned per female of each age-group during a spawning season. The ovaries as indicators of the length of spawning season in freshwater fishes are discussed.

The eggs of the greenside darter are spherical, transparent, demersal and adhesive. A prominent yellow oil droplet is present. The embryo is figured and described from the 2-cell cleavage stage to the time of hatching.

Age determination was accomplished by the scale method.

Editors Note:

An abstract originally occupying this space was based upon a mimeographed report. Before this issue went to the printer the author requested that the abstract be withdrawn since the article was being submitted for publication in a technichal journal.

270. Cross, R. H. 1954. THE BARBOURS CREEK PLAN. Virginia Wildlife Vol. XV, No. 4, April, pp. 5-7.

The old "opening day rush" is nothing new to fishermen who frequent the trout streams in the western part of Virginia. Sportsmen have complained for years, but the only thing that's happened is a new crop of "standing room only" stories after each season. Nobody seems to enjoy the congestion and confusion, yet they continue to go in self-defense. If an individual can't get to a stream within the first three days, he's literally "missed half the fishing." A minimum of 53 percent of the stocked trout was removed from one test stream during the first 2 1/2 days of the 1953 season.

Barbours Creek, which originates and flows

through approximately five miles of the Jefferson National Forest, was chosen as a suitable place to test this trout stocking plan which had been developed previously in Vermont on the New Haven River.

The New Haven experiments in Vermont were designed to test the validity of theory that brooks, when released, go upstream while the rainbows head downward for the larger waters. A series of closed sections, alternating with areas of open water, were established on the river and marked trout were released in sections closed to fishing. A continuous creel census indicated that generally neither species showed any preference with regard to direction of emigration.

It was found that fish placed in closed sections gradually moved to open waters, thus providing uniformly good fishing for a considerable period in a stream which was normally fished out during the first two or three days of the season. It was with this thought in mind that the Commission, cooperating with the United States Forest Service, set about establishing a group of alternate closed and open areas on Barbours Creek in 1950. Immediate results were encouraging enough for these efforts to be continued and at the present time everyone is still enthusiastic. These areas, three in number, are each 2/10 of a mile in length and spaced one mile apart.

The Barbours Creek Plan is making more trout available over a longer period of time. In addition to improving the fishing as well as reducing angler concentration, the Barbours Creek Plan has brought to mind another important fact. Virginia's sportsmen, both hunters and fishermen, are all interested in the state's game and fish management projects and problems.

Of course, the Barbours Creek restocking program has certain limitations. The closed sections must be fairly accessible to fish trucks and restocking teams. It is not practical to carry fish long distances by hand. There is also some doubt if the plan would work on private lands, because of the enforcement angle. National Forest streams, all open to public fishing, offer perhaps the best outlet for this new stocking technique.

271. Martin, Robert G. 1954. WHAT THE DOUTHAT LAKE STUDY REVEALED. Virginia Wildlife, Vol. 15, No. 7, July, pp. 10-12.

Considering the low fertility, meager feed supply and restricted growing space found in Douthat Lake, it was not surprising that few fish were taken during netting and seining operations. The proportion of bass and pickerel to pan fishes such as bream and crappie was unusually high. Indications that a large sucker population existed was the only evidence of serious population unbalance.

Creel census statistics gathered faithfully echoed the complaints of poor fishing voiced by disgruntled anglers. Well over half of the fishing trips were unsuccessful. The average catch per trip was only 1.2 fish (0.3 pounds) of any and all species. Only one out of every 19 fishing trips produced a bass.

The total number of fishes angled during the season was only 1,200 weighing approximately 280 pounds. About 50 pounds of this total was made up of largemouth bass. This represents a total yield of slightly less than five pounds of fish per acre including approximately 0.8 pounds of bass per acre.

The lake had to be drained at the conclusion of the fishing season to repair a faulty drain, and all of the fish were removed from the lake, sorted, weighed, and either confined in holding pens for eventual return to the lake or released in nearby streams.

A total of 2500 pounds or slightly over 40 pounds of fish per acre were recovered from the lake. Bream made up the largest percentage of the total, 42 percent. White suckers, comprising 25 percent, were next in abundance. Largemouth bass, 14 percent; chain pickerel, 10 percent; and black crappie, 9 percent, rounded out the major species covered. In addition, a limited number of rainbow trout, blue-spotted sunfish, madtoms, and bullheads were taken.

When comparing the fishes taken by anglers, 280 pounds, during the fishing season with the fishes recovered at draining, 2,500 pounds, it is apparent that the lake was not "fished out." In fact, these figures show that 89 percent of the original population was still swimming in freedom at the conclusion of the fishing season!

In view of the poor fishing manifest by creel census data and the limited number of fish found at drainage, it was apparent that corrective measures would have to be taken to appreciably increase fishing success. With this in mind, the following steps were taken: (1) All suckers were removed, (2) practically all of the smaller size groups of the bluegill, pumpkinseed and crappie were removed, (3) all bass were returned to the lake, (4) only enough chain pickerel were returned to insure adequate reproduction, (5) supplemental stockings of adult largemouth bass will be made in late spring in the hope they will enjoy good survival, and (6) finally, it was recommended that the lake be closed to fishing until June 20. However, since only 11 percent of the available fishes were being caught by anglers, it was recommended that Douthat Lake be opened to year-'round fishing for all species after June 20, 1954.

272. Clothier, William D. and Marvin F. Boussu. 1954. PRELIMINARY OBSERVATIONS ON THREE BLACKHILLS TROUT STREAMS. South Dakota Conservation Digest, Vol. 21, No. 3, March, pp. 3-7, 11.

The report deals with population and creel census checks made last year (1953) on portions of Spearfish, Rapid and Box Elder Creeks to provide information on creel returns of three species of legal-size trout (six inches or more in total length). The study streams originate in Lawrence County at elevations ranging between approximately 6,000 and 6,500 feet. All drainage is toward the Missouri River. Each stream gradually loses its identity as a trout water as it approaches the foothills.

Eight, 200-foot sections were selected and permanently marked in each study area. These were censused once early in the fishing season (June 16-

26) and again immediately following its close (October 16) by means of a 240-volt, direct current "shocker" generator. Each fish captured was weighed, measured, and returned unharmed to the section from which it was removed.

Three separate "spot plantings" of 1,800 trout (900 per study area) were made at approximately 3-week intervals between the two census periods in Spearfish and Rapid Creeks. Equal numbers of brown, brook and rainbow trout were stocked each time. Box Elder Creek received 2,250 brown trout only during the same period. The stocking rates for each planting were approximately 150 fish per mile in Spearfish and Rapid Creeks, and 200 per mile in Box Elder Creek.

More legal-size trout, including both hatchery and wild fish were found in Rapid and Box Elder Creeks immediately following the fishing season than were taken during the June census. Spearfish Creek showed a slight decrease in legals.

In the two streams which received equal numbers of each species of trout, brown trout comprised 58 percent of the total number recovered at the end of the fishing season; rainbow trout comprised 32 percent; and brook trout 10 percent.

Marked recoveries from individual study areas in October show an average weight loss of from 15.9 to 30.8 percent of the July 9 hatchery averages. Average weight losses in ounces ranged from 2.4 to 5.1. No instance of a weight gain was indicated out of the 71-fish sample. Significant loss differences between species could not be shown.

A creel census clerk contacted fishermen during the period July 3 to September 30. A total of 443 fishermen were interviewed. They had fished 1,044 hours to catch 432 trout. Marked hatchery trout comprised 43.3 percent of the catch in Spearfish Creek, 43.2 percent of the catch in Rapid Creek, and 54.5 percent of the catch in Box Elder Creek. The catch rate in all creeks combined was 0.41 fish per fisherman hour (1 trout for every 2.44 hours of fishing effort). A trout stream can be considered excellent when it yields 1.0 fish per hour of fishing contrasted to about 0.25 fish per hour for a very poor stream. Large fish will compensate somewhat for a slow rate of catch.

The average catch per hour on individual streams was 0.41 in Spearfish Creek, 0.49 fish in Rapid Creek, and 0.28 fish in Box Elder Creek.

In the present study, brown trout contributed least to the creel on a percentage basis and brook trout the most. This is in complete agreement with the "shocker" census, in that brown trout comprised the largest percentage of marked fish remaining in the streams at the end of the season, and brook trout the smallest. Rainbow trout consistently occupied an intermediate position.

273. Boussu, Marvin F. and William D. Clothier. 1954. A FISHERIES REPORT ON LAKE MADISON. South Dakota Conservation Digest, Vol. 21, No. 4, April, pp. 9-11.

The first biological examination of Lake Madison was made in August 1951, (Gibbs and Allum, 1952) to provide information for a fishery management program. Frame net catches at this time took an average of 3,080 bullheads and only 4 game fish per 24-hour set. Average length and weight of the bullheads (9.4 inches, 0.45 of a pound) were still desirable, although the absence of larger or smaller size groups showed that the population was becoming "stagnant" and would soon stunt. The Fisheries Division consequently recommended that a bullhead reduction program be instituted. Local sportsmen, although by no means unanimous in their approval, supported the proposed management plan, and subsequent action by the Department enabled operations to begin in the winter of 1951-52.

During the first winter, 471,200 pounds (live weight) of bullheads were removed by commercial trap netting from Lake Madison. Test net checks the following summer showed a decrease of from 97.8 to 73.0 percent in the total bullhead population, and a new size group appeared. Removal operations were continued during the winter of 1952-53, and an additional 133,530 pounds of bullheads were removed.

By 1953 the most forceful impact of the removal operations had been, quite naturally, on the bullhead. The average length and weight of this species increased 21 and 111 percent, respectively. Frame nets which averaged 3,080 bullheads per 24-hours in 1951 took only 43 during the same length of time in 1953. Gill net catches showed a similar trend, with an average catch of 471 bullheads per 24-hours in 1951 and 9 in 1953.

Game fish (walleyes, northern pike, perch, crappie, bass, catfish and bluegills), conversely, increased their numbers. Frame net catches of these species increased from 4 per standard set to 23, and gill net catches from 39 to 193.

Changes in population shown by test netting are reflected in the creel census returns. The bullhead catch dropped from a high of 3.23 bullheads per hour of fishing in 1951 to 0.45 in 1953. Game fish which in 1951 showed a catch rate of 0.00 (no game fish caught by the average angler in 100 hours of fishing), increased to 0.10, or one game fish per 10 hours of fishing.

274. Clothier, William D. and Marvin F. Boussu. 1954. THE 1953 VOLUNTARY WARDEN CREEL CENSUS. South Dakota Conservation Digest, Vol. 21, No. 5, May, pp. 8-11.

A voluntary warden creel census provided information on angler success from 114 lakes, ponds and streams in 38 counties of the State during the 1953 fishing season.

A total of 2,244 fishermen were contacted during the 1953 census. Of these 68.8 percent were licensed men fishermen. Unlicensed women (17.1 percent) and children (14.1 percent) fishermen comprised the remainder.

Only 7.8 percent of the anglers censused were nonresidents, representing 11 States.

Combining the creel bags of all warm water anglers gives a statewide average catch rate of slightly more than one-and-one-half (1.58) fish per hour. Trout enthusiasts worked nearly three times as long (0.54 fish per hour) to catch the same

number of fish. The total catch composition of warm water fish by species is: perch 34.2 percent, bullheads 34.1 percent, crappies 16.6 percent, walleye 6.1 percent, bluegill 3.3 percent, largemouth bass 2.9 percent, northern pike 2.3 percent, and channel catfish 0.5 percent.

275. Ruhr, C. E. 1954. SMALLMOUTH STREAM MANAGEMENT STUDIED. Tennessee Conservationist, Vol. 20, No. 2, Feb., pp. 10-13.

Four main characteristics of a good smallmouth-rock bass stream are: (1). A maximum water temperature of 85 degrees. (2). Water that is characteristically free of silt except during flood. (3). Rock or gravel bottom. (4). Frequent pools and riffles.

It may seem peculiar that though this type of stream is characterized by the smallmouth, the smallmouth is only third or fourth in abundance among the game fish and almost insignificant when compared to the numbers of rough fish. This is because the smallmouth grows larger than most other game fishes such as the sun perch and rock bass.

When a stream tends to have longer slower pools, less frequent riffles and slightly higher temperatures, the smallmouth frequently gives way to the spotted or Kentucky bass.

Now we should consider the relative poundage of different kinds of fish in a typical smallmouth-rock bass stream. A typical stream may contain approximately 900 pounds of fish per mile. This, of course varies greatly with the size and condition of the stream. Of this 900 pounds, non-game fish make up 70 percent and game fish 30 percent. There may be 40 percent redhorse, 20 percent hog suckers, 7 percent stonerollers, and 3 percent miscellaneous non-game fish. Game fish will be 10 percent smallmouth bass, 7 percent rock bass (black perch), 7 percent longear sunfish (sun perch), 3 percent Kentucky bass, and 3 percent miscellaneous game fish including largemouth bass and bluegills. There may be streams which do not conform to this make-up, but they are usually not good smallmouth-rock bass producers.

Tennessee smallmouth stream management consists of five main points:

1. Encouragement of watershed management. The accumulation of silt in our smallmouth streams is probably one of the most adverse factors affecting our smallmouth and rock bass. Farm practices such as contouring, terracing, and planting of soil holding crops are of tremendous benefit to our smallmouth-rock bass streams.
2. Curbing pollution.
3. Stream improvement.
4. Stocking. Stocking is probably the oldest and most popular form of smallmouth stream management. Recent investigations show, however, that stocking is not always the answer. If the eggs and fry that are produced naturally do not survive, there is little chance that artificially stocked fingerlings will survive. There are rare cases in which streams are found to need help with stockings.
5. Law enforcement. Some of the most destructive fishing practices conceived by man may be found in stream seining, poisoning, and dynamiting. We must devote much effort to convincing these few destructive people that they are robbing our streams.

276. Cutbirth, W. J., Jr. 1954. POLLUTION CONTROL IN TEXAS. Texas Game and Fish, Vol. 12, No. 9, August, pp. 6, 26-27.

Two state agencies safeguard Texas waters against pollution. The Department of Health is concerned when human welfare is involved. The Game and Fish Commission steps in when pollution endangers fish or wildlife. This article presents a summary of laws and the commissions policy. Particular emphasis is placed on oil pollution.

277. Smallhorst, D. F. 1954. POLLUTION CONTROL IN TEXAS. Texas Game and Fish, Vol. 12, No. 13, December, pp. 9, 22.

This article is the companion to the above article. It deals with the laws governing the Health Department's role in pollution and how the department functions. Emphasis is on sewage pollution.

278. Barnes, R. C., Jr. 1954. HIT FLOODS WHERE THEY START. Texas Game and Fish, Vol. 12, No. 10, Sept., pp. 5-6, 27-28.

Interest in watershed protection on the small upstream tributaries of a number of our Texas streams is increasing every day. Not only does such an approach provide for better use and conservation of the soil and water in the watershed, but one of the end products is a better habitat for fish and wildlife. It is recognized that Texas can never have an effective wildlife conservation program, except by building it around the conservation needs of the soil, forest, ranges, water and other natural resources that are so completely tied together with wildlife.

Texas is going through a prolonged period of drought. When the rains do come again, however, we shall see a recurrence of damaging floods; floods which denude the land of irreplaceable topsoil, that drown out valuable crops, that deposit sediment on fertile bottomlands, that silt up streams and reservoirs, that wash away valuable property, and cause untold human hardship and suffering.

Approximately two-thirds of this flood damage will be suffered in the watersheds and floodplains of the small tributaries of our main streams.

A watershed protection program conforms with several basic principles. First, floods begin where the raindrops fall. Good conservation land use to keep the water where it falls and to get it into the soil for plant use, or to provide underground water for springs and streams, is essential.

This means using the soil according to its capabilities and treating it according to its need, to protect it, to improve it and to keep it productive from now on.

This means also the use of terraces and contour cultivation to break up the slope lengths, and

grassed waterways to dispose of runoff without erosion damage. And it means conservation management of range and pasture land to provide better cover and to break up the force of falling raindrops and increase water intake by the soil.

Secondly, even with the best land use and treatment, runoff will occur at times because rains often fall at a rate faster than the soil can absorb the water, or the soil may already be saturated when the rain falls and can store no more water.

The frequently recurring floods caused by this runoff can be best handled by small floodwater retarding structures on the headwaters and tributaries of our streams. Their purpose is not to store large amounts of water but to hold the runoff temporarily, releasing it slowly through automatic drawdown devices at a rate which will reduce or prevent flooding on the bottomlands below.

Thirdly, a basic principle in watershed protection is that people must work together to accomplish their over-all common objective.

Typical of such a group are the farmers and ranchers in Deep Creek, near Brady, Texas, a tributary of the Middle Colorado River. The Soil Conservation Service assisted in preparing a watershed protection plan on this watershed, comprising some 46,000 acres, which was completed in December of 1950. Flood damages in this watershed were high.

The plan, as developed, calls for the application of the needed land treatment measures as follows: (1) Construction of 326 miles of terraces to control erosion on the cultivated land; (2) Improved pasture and range management on 34,225 acres; (3) Construction of 24 miles of diversion terraces and other related measures.

On October 3-5, 1953, the faith of the people in the Deep Creek watershed was justified. A 7.23-inch rain fell on the watershed during a 30-hour period, 1.35 inches of which fell in a 20-minute period. Only five of the planned floodwater retarding structures had been completed, and only about 40 percent of the conservation treatment on the land had been done.

Some 1,245 acres of the flood plain were flooded by this rain. It is estimated that 2,770 acres would have been flooded if the watershed-protection work had not been done.

Local residents stated that, due to the temporary storage provided in the floodwater-retarding structures, high water marks were three to eight feet lower than following a similar storm in 1938.

This program, when completed as planned, will also adequately protect the uplands through good, sound conservation land use.

279. Mueller, John W. 1954. WYOMING STREAM IMPROVEMENTS. Wyoming Wild Life, Vol. 18, No. 5, May, pp. 30-32.

The improvements on Clear Creek were installed in 1950 and proved worthy for a period of two years. At the present time, only one improvement is intact and this is an anchored log with rocks piled on the upstream side. The types of improvements used were rock and boulder dams, rock deflectors "A" deflectors, and digger logs. Good pools were formed from what was once a long continuous riffle area.

Since these improvements were constructed, this section of stream was shocked on different occasions and an average of 528 fish per mile were counted.

Unfortunately the Beaver Creek improvements were not as practical. They were installed in 1950 and began to wash out the following year. During the summer of 1952, only two remained in good condition, ten were in fair condition and eleven were completely washed out. It is possible that no improvements remain at the present time. Electro-fishing indicated that some of the remaining improvements were being utilized. The following table shows the fish population found to exist:

Year	Fish Mile	Ave. Size
1950	264	8 inches (before improvement)
1951	180	9 inches (after improvement)
1952	233	10 inches (after improvement)

Although the number of fish per mile decreased in 1951, an increase of 53 fish per mile was noted the following year. The average size increase during the two-year period was two inches. The stream thus showed improvement by the increase in the weight of fish it was able to maintain.

Approximately one mile of Porcupine Creek was improved with rock dams and wing deflectors. Altogether 29 improvement devices were constructed. Because this section of stream is readily accessible and is heavily fished throughout the season, it was decided to make an effort to improve environmental conditions more conducive to trout populations. The primary purpose of improvement was to create larger and better pools.

The improvement results seemed favorable during their first year. The devices were constructed during the summer of 1950 and during the summer of 1951 all, or nearly all, were still intact, and a total of 1,237 fish (or 31 lbs.) per mile were found to exist there. Their average length was 4 inches. Shocking operations in 1952 gave 678 fish (or 34 lbs.) per mile and their average length was 5 inches. Of the original improvements, 7 were still in good condition, 16 were in fair condition, and 6 were washed out completely and were of no value as far as stream improvement is concerned.

Observations show that improvements made up entirely of rocks and boulders do not remain intact over a period of years. A more substantial improvement, such as a log butted into the stream banks with rocks piled upstream to the log, or cribbed and anchored structures of various kinds should be constructed to withstand the runoffs encountered in most Wyoming streams.

280. Greene, A. F. C. 1954. FISHING IN WYOMING (in 4 installments). Wyoming Wild Life, Vol. 18, Nos. 7, 8, 9, 10; July-October.

This series of articles presents life history data

and information on how to catch 26 species of fish. Wyoming has recorded 83 species and 21 are classed by law as game fish. The first two installments cover coldwater forms, the last two the warmwater species.

281. Holton, George D. and Rex M. Corsi. 1954. IN WINTER IT'S WHITEFISH. Wyoming Wild Life, Vol. 18, No. 11, November, pp. 16-18.

The mountain whitefish is a neglected resource. It is an excellent game species, native to Wyoming, whose close relatives are eagerly sought food fish in the Great Lakes region. Unfortunately, whitefish are overlooked by most Wyoming anglers during the regular fishing season.

Whitefish tend to compete with trout for food. Since trout are harvested whereas whitefish are not it would seem, in theory at least, that whitefish are given an advantage and are being allowed to increase at the trout's expense.

The ideal way to control whitefish populations is to have them harvested by anglers. Winter is an especially good time to concentrate on them since trout eat less and less as water temperatures drop while whitefish have good appetites even during the coldest months. In a Montana study, whitefish stomachs taken during the winter contained over five times as much food as stomachs of trout. Opening a winter whitefish season, therefore, not only permits use of an otherwise neglected game fish but also provides fishermen additional sport with minimum danger to trout.

A study of the angler harvest was made during the 1954 season. The objective of the study was to determine: The response of anglers to a winter whitefish season; the success of anglers in catching whitefish; the effect of a winter whitefish season on trout, that is, would many trout be hooked?; and the sizes and ages of whitefish harvested.

A creel census was made on 10 Saturdays or Sundays and six week days during the 74-day season. In all, 230 fishermen were checked.

The 230 fishermen caught 2,257 whitefish in 521 1/2 hours of fishing. This is an average of 4 1/3 fish per hour. Indeed excellent fishing! One fish per hour is considered good when fishing for trout. On an average, each angler had over nine whitefish when checked—and most fishermen had not finished for the day. The 230 fishermen had hooked only six trout; these had been released.

The most popular lures were stonefly nymphs—small size and light color preferred. Most whitefish were caught in pools or where riffles break into pools. Larger fish seemed to be caught in faster water than were the smaller ones.

The length distribution of the whitefish was obtained by measuring the over-all lengths of 508 fish from anglers' creels. Fish 11.0 to 14.9 inches long predominated. The average length was 12.8 inches. The largest whitefish checked so far during the winter seasons was 21.7 inches and weighed 3 1/4 pounds.

A study of fish scales taken during the 1954 creel census showed that the youngest whitefish caught were two years old, that the majority were three or four years old and that some were as old as seven years. This indicates the population has been only lightly harvested, if at all, in the past.

The study of winter whitefish fishing will be continued in the coming years in order to further evaluate the effect on trout and whitefish populations. Winter whitefish seasons show promise of benefitting both sportsmen and trout.

282. Raver, Duane. 1954. HOW FISH ARE IDENTIFIED. Wildlife in North Carolina, Vol. 18, No. 5, May, pp. 9-11.

A useful key to the families of fishes is presented. Following identification to family, the species may be determined from a double page chart which pictorializes the major difference or differences between the species.

283. Anonymous. 1954. INVESTIGATING THE SURVIVAL OF HATCHERY TROUT. Wyoming Wild Life, Vol. 18, No. 4, April, pp. 20-25.

Intensive investigations of the survival of hatchery reared trout under varying conditions have been carried out in different parts of the United States during recent years. The first such project in Wyoming began in 1952 and was carried on in 1953 on a section of the Big Laramie River in Albany County. A related project, concerned with a comparative study of naturally produced and hatchery produced fish, was conducted on Clear Creek in Johnson County. Both studies are concerned with brown and rainbow trout.

Clear Creek, one of the main tributaries of the Powder River in Wyoming, is located in the northeast section of the State, draining the east central slope of the Big Horn Mountains in Johnson County. The study section of the creek lies in the foothills area at an elevation of approximately 4,470 feet. Climatic conditions are typical of the foothills of the Wyoming Rockies. Stream velocity is generally rapid with fairly regular succession of pools and riffles through the middle and upper study sections, with the lower portions grading into a somewhat sluggish velocity.

Brown and rainbow trout are the permanently established species of game fish for this section of Clear Creek.

In order to give a more definite indication of the relationship of hatchery fish to the wild trout population of the experimental waters, a final stocking of marked trout was made in early August, 1952. Forty-two hundred fin-clipped brown trout averaging eight inches in length were released at that time. Distribution was made as evenly as possible at fifteen locations in the study waters.

The unit of fishing quality for days checked during 1953 averaged 0.98 trout per fisherman hour as compared with a success of 1.57 trout per hour for the latter part of the 1952 season. A more significant comparison is made with the latter part of the 1953 fishing season subsequent to August 10. During 1952, 58.2 percent of the trout taken after this date were hatchery fish. In 1953 a check on the comparable period revealed the percentage of hatchery trout in the creel to be 4.7 percent. The

fisherman success per hour during this period in 1953 was 1.9 fish compared to the entire season average of 0.98. In making further comparisons of the two late season censuses, hatchery trout contributed much more heavily to the creel in 1952 than in 1953, yet no significant increase in the quality of fishing is found for the former season as might be expected to result from those anglers fishing directly after the hatchery truck.

The results from electro-fishing at all sampling stations in July showed 17.8 percent of the total catchable size trout to be hatchery fish, whereas, in November, the figure dropped to 0.23 percent.

The combined findings from both the creel census work and electro-fishing evidenced a marked decline in the number of hatchery trout occurring in the creel consistent with a decline in the numbers found inhabiting the experimental waters. From data available this decline occurred as a result of the direct exploitation of this group by the angler. From the economic standpoint involved in providing a false fisheries resource this is considered as a favorable consequence, since the investment required to raise an 8-inch trout makes it highly desirable that fish of this type are caught before mortality ensues. Natural reproduction from such a planting is not ordinarily anticipated.

A definite downstream movement of all trout species was evident, especially during the late fall and winter months. During the spring and summer, movements do not appear as pronounced but a gradual spreading out and a trend upstream is indicated.

Objectives of the Big Laramie River portion of the project were to arrive at an estimation of the percentage survival to the fisherman's creel of hatchery reared fish of various sizes and species planted at various times of the year, in the same stream and to work toward an eventual estimation of the mortality in the stream of these same fish.

Comparison of the estimated percentage returns from the different categories of hatchery planted fish as to size, species and the time of year indicate that fall-planted rainbows in the 9 to 12 inch group showed the highest return (29.20%). The percentage of returns from brown trout in the 2 to 6 inch size group was low, (0.09%) probably due to the inability of this size trout to take a lure.

The creel census indicated, however, that about 70 percent of the fish taken in the study area were wild fish. Just under 60 percent were wild browns and approximately 10 percent were wild rainbows. Hatchery brown trout in the seven to nine inch category and planted at various times of the year made up the bulk of the "tame" fish taken by fishermen in the study area.

Following shocking of the stream in the late fall, it was estimated on the basis of fish 3 inches and under, that approximately 50 percent of the total fish population was the result of the previous year's natural propagation of the resident brown trout.

284. Van Meter, Harry. 1954. FISHING IMPROVES IN 1953. West Virginia Conservation, Vol. 17, No. 11, Jan., pp. 21-26.

Creel census records for the past year have indicated improved fishing. Over 27,000 records were obtained. On trout waters, 19,183 anglers caught 34,945 trout at a rate of 1 trout per 2.3 hours fishing. Fifty-four percent of the anglers were successful in taking trout, and 12 percent caught their limits. On warm waters, 7,844 fishermen caught 23,929 fish at a rate of 1 fish per hour. Forty-eight percent of the fishermen were successful.

285. Van Meter, Harry. 1954. FISH MANAGEMENT. West Virginia Conservation, Vol. 18, No. 8, October, pp. 8-13.

This article is part of the annual report of the West Virginia Conservation Department and covers the program and activities of the fishery section for the fiscal year 1953-1954.

286. Carlander, Harriet Bell. 1954. A HISTORY OF FISH AND FISHING IN THE UPPER MISSISSIPPI RIVER. A publication sponsored by the Upper Mississippi River Conservation Committee. 96 pgs.

This report on fishing on the Upper Mississippi River covers the period from the time when records were first kept of fishes caught by pioneers, discusses the changes in the river, the effects of the fishing upon commerce (mussel fishing and the pearl button industry), commercial fishing and sport fishing to the present day.

287. Meyer, Marvin C. 1954. THE LARGER ANIMAL PARASITES OF THE FRESH-WATER FISHES OF MAINE. Maine Dept. of Inland Fisheries and Game Fishery Res. and Mgt. Div. Bulletin No. 1, 92 pgs.

This bulletin is divided into two parts, the first part is directed toward the sportsman and a glossary is included to aid in the explanation of those technical terms the use of which could not be avoided. This section also deals with the biology of parasites, ie., how they are acquired, their effects upon the host, their transmission to man as a result of eating infected fish, and control measures being used and recommended.

Part Two is more technical. It gives the groups of parasites involved, their life cycles and species encountered.

288. Johnson, Leon D. 1954. A WAY TO FIND IT. Wisconsin Conservation Bulletin, Vol. 19, No. 5, May, pp. 5-8.

This article was a popular account on finding ways to improve muskellunge production. Small muskellunge, three-quarters of an inch to six inches in length were collected and their stomach contents analyzed. Suckers put in ponds for muskellunge food were also examined. It was found the suckers were usually full of plankton but the muskies never were. An experiment was tried in which the muskellunge were stocked in ponds without sucker fry for food at first. When stomachs of these muskies were examined they were found to be full. The muskies grew fast and when sucker fry were added the muskellunge readily ate them. Sixty-seven percent of the total muskellunge harvest was obtained from 21 percent of the pond area where

muskies were stocked first.

Vegetation was removed so that fertilizer would be more effective in plankton production. Predatory insect larvae, such as dragon fly and water tiger, caught and ate small fish. Baby fry often suffocated on the bottom because of low oxygen due to decomposition. Some muskellunge died of starvation because they could not locate the right sized food. The larger 2- to 3-inch muskies died of starvation because they had had a taste of fish and too few were available for them. Some muskies also became entangled in filamentous algae and died. Work continues to correct the deficiencies.

289. Christenson, Lyle, Vernon Hacker, and Oscar Brynildson. 1954. DOES FALL TROUT STOCKING PAY? Wisconsin Conservation Bulletin, Vol. 19, No. 1, Jan., pp. 15-17.

Does fall trout stocking pay? In an effort to answer this question as pertains to Wisconsin, studies involving brook and brown trout were made to determine the return to the angler of fall- and spring-planted fish. In addition, the fish populations were sampled by means of an electric shocker to determine which plant was more available to the anglers. These studies were conducted on streams in three scattered sections of the State.

The two streams selected for brook trout studies were Tank Creek and the North Branch of the Trempealeau River, both in Jackson County. Both are considered to be better-than-average brook trout streams from the standpoint of water temperatures, bank cover, and fish shelter.

Marked brook trout six to eight inches long were stocked in both streams October 2, 1952. Equal numbers of trout, of approximately the same size, were planted April 29, 1953.

On Tank Creek, the ratio of observed returns to the angler of fall- and spring-planted brook trout was 1:9; that is, with equal numbers planted in both fall and spring, only one fall-planted brook trout was caught by anglers for every nine spring-planted fish.

Shocking operations on Tank Creek during the first week demonstrated that for each fall-planted fish there were 12 spring-planted brook trout available to the angler.

On the North Branch of the Trempealeau River, the results were considerably different. In the anglers' catches examined, the ratio of fall-planted to spring-planted fish was 1:3.

During the course of the electric shocking operations on the North Branch of the Trempealeau River, one fall-planted brook trout was recovered for every four spring-planted trout.

The two streams selected for the brown trout studies were Willow Creek in Waushara County and Rocky Run Creek in Columbia County.

On Willow Creek, the ratio of observed returns of fall- and spring-planted brown trout to the anglers was 1:7. Shocking operations, however, disclosed that there was one fall-stocked brown trout for every two spring-planted fish actually present in the stream.

On Rocky Run Creek, the ratio of observed returns to the anglers of fall and spring-planted fish was 1:5. Electrofishing demonstrated that there was one fall-planted brown trout for every two spring-planted brown trout in the stream just prior to the opening of the trout season.

On the basis of the evidence presented above, considering only trout for trout, it certainly appears that as a general rule, fall-stocking of six- to eight-inch trout does not pay!

290. Schneberger, Edward. 1954. WISCONSIN TROUT MANAGEMENT. Wisconsin Conservation Bulletin, Vol. 19, No. 1, Jan., pp. 11-14.

Trout fishing has long been looked upon as one of the most sporting and challenging of all types of fresh-water fishing. Research has shown a number of weaknesses in the present trout management procedures. Therefore, if we are to eliminate wastes and improve efficiency of operation, an overhaul of the program is in order.

Fish propagation and stocking in Wisconsin began in 1872. Unfortunately, the needs for stocking and the benefits (or failures) of stocking were not carefully studied prior to enactment of such a program. It was during the 1930's that fishery biologists began to make investigations as to the survival of artificially and naturally propagated fish. Since then the findings of research show that much of the stocking does not provide the benefits once believed.

Every researcher from east to west, north to south, in Canada, New Zealand and other foreign countries have independently arrived at these general, well substantiated conclusions, after 20 years of research on this problem:

1. The stocking of fingerling trout in most streams results in only about one percent of those stocked ever reaching the angler creel.

2. Trout fingerling stocked in lakes can develop some very nice fishing.

3. Legal-size trout stocked in the fall after the season closes have a very low percentage of survival and, therefore, this is a wasteful procedure.

4. The most effective method of trout stocking in streams, i.e., giving the highest percentage of return to the creel, is the stocking of trout of legal size during the open season and in areas of the greatest fishing pressure.

5. Trout produced by natural propagation bear the brunt of the fishing pressure.

Concluding that to get the best returns from the legal-size trout program the fish must be stocked where the fishing pressures were the greatest, the fish management division was then faced with the problem of determining such fishing pressures. It was deemed advisable to make allotments of the state's production of trout on an index of fishing pressure as determined by consideration of six factors, namely: (1) Aerial survey of actual fishing intensity, (2) number of trout fishermen, (3) population density, (4) resident fishing licenses sold, (5) nonresident fishing licenses sold, and (6) number of tourist accommodations in each area.

The two most neglected phases of a trout management program are: (1) Habitat restoration and improvement, and (2) fact finding or research.

The department's enacted watershed management program is aimed at correcting unfavorable conditions and basically this is essentially a proper land-use program. There are two factors that should constantly be stressed: (1) Even though the basic reason for such a program from the fish management standpoint is to improve conditions for fish, it may not be possible to show sufficient improvement in fishing to justify the costs. In other words, other benefits will have to be measured, weighed and credited. Conservationists must determine if they want their monies spent in this direction. (2) Programs must be planned, executed with the most meticulous caution and care. It would be easy to make many costly mistakes and waste thousands of dollars.

The use of research as a tool in conservation management has been unduly neglected. If we are to have a sound trout management program, it must be based on facts and facts are available only through careful research.

291. Probst, Robert T. 1954. WHY STUDY STURGEON? Wisconsin Conservation Bulletin, Vol. 19, No. 3, March, pp. 3-5.

The sturgeon is without question the most unique fish in Wisconsin. Sturgeon are slow growing and live a long time. Studies in other areas have shown that female sturgeon do not spawn for the first time until they are about 22 years old, and that the males mature when about 15 years of age. There are indications that the females only spawn every 5 or 6 years and the males every other year. At the time of the first spawning, females measure approximately 50 inches in length and weigh about 30 pounds. As the males mature at an earlier age, their size at maturity is smaller—about 33 inches in length and 7 or 8 pounds in weight.

Our present regulations stipulate a 30-inch minimum size limit. If this is designed to save the sturgeon from the fisherman until it has reproduced at least one time, it is far from adequate. Michigan, one of the other few states having an open sturgeon season, has a minimum legal length of 42 inches. Even at this length, the females are subject to harvest prior to spawning for the first time. Perhaps a modification of our regulations is in order too, or do we wish to continue to crop our sturgeon before they grow up?

In the meantime, however, if the sturgeon fishermen are to realize the greatest immediate benefits from this fishery and at the same time provide for the future of this sport, we must obtain more complete information on the total catch of sturgeon from our waters and the rate at which this population is being sustained by natural reproduction.

292. Klingbiel, John and L. E. Morehouse. 1954. DOES MUSKY STOCKING PAY? Wisconsin Conservation Bulletin, Vol. 19, No. 10, Oct., pp. 17-19.

An experiment was initiated in 1950 to evaluate the practice of stocking muskellunge from the standpoint of returns to the fishermen's creel. High and Fishtrap Lakes in Vilas County were chosen as sites for the experiment because of their reputation of being good musky lakes for many years.

In order to evaluate a stocking program, each fish stocked was marked with a red plastic tag about 1/4 x 1 inch in size, that was inserted into the body cavity through a slit made just in front and to the side of the vent. In a short time the incision is healed up.

In May 1950, 488 tagged yearling muskies ranging from 7 1/2 to 13 inches were stocked in High Lake and the next year 310 more were placed in adjoining Fishtrap Lake. Because muskies normally take 5 years to become the legal 30 inches, it was expected that in 1954 fishermen would begin to catch some of these fish from High Lake and those in Fishtrap would begin to show up a year later. However, in June 1953, a year before expected, the first tag was returned from a legal High Lake musky.

Throughout the 1953 season, 35 legal muskies were reported from High Lake, 15 of which contained tags identifying them as stocked fish. These fish had not only survived the tagging operation, but also had grown from 10 1/2 inches to 31 1/2 inches in less than 4 years. Sixty-four legal fish were reported taken from Fishtrap Lake, but, as expected, none were tagged.

During the 1953 season, 15 of the 488 yearling muskies planted in High Lake were creeled as legal fish. Although this number is relatively small, it still composed more than 40 percent of the recorded catch.

The results of this experiment, although now far from completion, may aid in guiding propagation men to the most effective type of stocking.

293. Threinen, C. W. and Don Mraz. 1954. WE WON'T "FISH OUT" BASS. Wisconsin Conservation Bulletin, Vol. 19, No. 12, Dec., pp. 24-27.

Under the premise that largemouth bass populations were lightly exploited and that there was a tendency toward slow growth, the usual season was advanced from June 20 to May 15, and the former minimum size of 10 inches was eliminated on Brown's Lake.

It was estimated that there were 2,660 individual fish or 1,612.4 pounds of largemouth bass harvested in the open water fishing season of 1953. Forty-one percent of this total were under 10 inches long and 59 percent were more than 10 inches.

Many have thought that a bass fishery can be depleted by fishing early in the season; however, this evidence is contrary. The percentage of fish greater than 10 inches long caught the first week of the season was compared with the number of fish of similar size caught on the 14th week of the season. Seventy-five percent as opposed to 77 percent were greater than 10 inches—not an appreciable difference. Another significant feature of the angler-caught fish was that a large percentage (46.5 percent) were very nearly the same size, namely 10 to 12 inches.

If there was an estimated harvest of 2,660 fish, what remains for the future fisherman to depend upon? The answer comes with a population estimate. There were 20,000 largemouth bass over 6 inches in length left in Brown's Lake at the end

of the season.

Seining and handling individually 3,493 largemouth bass in the fall gave an intimate picture of the population. It was comprised of fish approximately one of three sizes, 6.5 inches, 9.0 inches, and 12.0 inches. These size groups are identified as two, three, and five-six year olds. The four year old fish were scarce. Largest of the three groups were the five-six year olds.

The harvest of 2,660 largemouth bass when added to the population of 20,000 gives 22,660 fish. Assuming that all of these fish were present at the beginning of the season, it is apparent that there was only an 11.7 percent harvest. When we know for a fact that walleyes in a northern lake have an angling attrition of about 20 percent, and that trout will frequently have a 50 percent harvest, there appears to be little need for concern about seasons or size limits on the largemouth.

Neither the early opening nor the elimination of the minimum size has had a significant effect on the largemouth of Brown's Lake to date and they are unlikely to in the future with such a large population.

294. Fish, Marie Poland. 1954. THE CHARACTER AND SIGNIFICANCE OF SOUND PRODUCTION AMONG FISHES OF THE WESTERN NORTH ATLANTIC. Bulletin of the Bingham Oceanographic Collection, Vol. 14, Article 3, April, 113 pgs.

Purposeful sound production in fish may be accomplished either by air bladder mechanisms or stridulatory mechanisms, and often by combinations of both. In all cases frequency characteristics are a key to the origin of the sound. Since most sonic fishes remain silent except when they respond to definite external or internal stimuli, individual experimentation is necessary to evaluate soundmaking habits. Accordingly, 60 North Atlantic coastal fishes were segregated and, where possible, were subjected to a series of carefully controlled situations and stimulations. Of these, 27 species produced sounds of biological origin, 27 sounds of mechanical origin, and six no sounds at all. Each species which demonstrated biological sound ability has been considered separately; characteristic outputs and spectrum analysis figures are described, the stimulation required for sound production is discussed, anatomical data on the mechanisms involved are given, and the significance of the species as a soundmaker is estimated. Experimental results indicate that sound may be used voluntarily as a means of communication, particularly to implement breeding, as an expression of fright, as a measure of defense or offense, as a response to environmental changes, or as a means of orientation; and sometimes there is no apparent reason for the sound. Involuntary sound production occurs under certain other stimulation. Included also are known data concerning geographical, seasonal, vertical and diurnal distribution as well as breeding habits, since these facts are essential in predicting the sounds produced by any species. (A)

295. Swingle, H. S. 1954. EXPERIMENTS ON COMMERCIAL FISH PRODUCTION IN PONDS. Ala. Poly. Inst. Agricultural Experiment Station, mimeo pamphlet, 20 pp.

Commercial production of fish in ponds appears feasible and highly desirable as a method of water and land utilization in many parts of the southeast. Preliminary experiments on the production of various species of fish on a commercial basis were begun at Auburn in 1948. The species tested included the round flier (Centrarchus macropterus), the bluegill (Lepomis machrochirus), the speckled bullhead (Ameiurus nebulosus marmoratus), carp (Cyprinus carpio), bigmouth buffalo (Megastomatobus cyprinella), smallmouth buffalo (Ictiobus bubalus), and the flathead catfish (Pilodictis olivaris).

The round flier and bluegill appear to have practically no commercial possibilities. The speckled bullhead showed some possibilities and a suggested procedure for production is given.

Work on the channel catfish is incomplete. The raising of carp also did not appear to be economically feasible as yet. Costs of fertilization and supplemental feeding to produce saleable size fish were too great in view of the low sale value of carp. A plan for raising carp was given.

Bigmouth buffalo offered better results than the smallmouth buffalo because of the greater ease in obtaining spawn from the bigmouth. Greater production was obtained for the bigmouth than for carp. Costs of fertilization were low enough to make commercial rearing of bigmouths economically feasible. A plan for rearing the buffalo is presented.

If methods of obtaining flathead catfish fry are developed it appeared likely that commercial production might be feasible since good growth was obtained in ponds.

296. Lawrence, J. M. 1954. WEED CONTROL IN FARM PONDS. Ala. Poly. Inst. Agricultural Experiment Station, litho. pamphlet, 3 pgs.

The problems of weed control can be greatly reduced in farm ponds, if the pond edge is deepened so there are no water areas shallower than 18 inches and the recommended fertilization program is followed from the time the pond is first filled with water. Since these practices are not followed in many ponds, and often even in well managed ponds some weeds may appear, other control measures are necessary to eliminate the water weeds.

It is generally recognized by fisheries workers that there are five major groups of aquatic weeds which must be controlled in a fish pond, if such a pond is to produce good fishing. These groups are as follows: filamentous algae, submerged weeds, emergent weeds, marginal weeds, and floating weeds.

Summarized are methods for controlling weeds in each of these groups, which have been selected from several references.

297. Lawrence, J. M. 1954. THE BLACK BASSES OF ALABAMA. Reprint from Ala. Conservation, Vol. 25, No. 5, pp. 12-16.

This article points out those characteristics by which a fisherman may identify the bass in his

catch. The information relative to the four species includes a sketch with accompanying descriptions of distinguishing marks, typical coloring, and types of habitats where normally found.

The four species of black basses which are described include the largemouth black bass (Micropterus salmoides Lacepede), the northern smallmouth bass (Micropterus dolomieu Lacepede), the spotted bass (Micropterus punctulatus Raf.), and the redeye bass (Micropterus coosae Hubbs and Bailey).

298. Van Meter, Harry. 1954. SPORT FISHERY SURVEY OF THE SHENANDOAH RIVER. pamphlet from the Div. of Fish Mgt., Conservation Commission of W. Va., 16 pp., multilith.

Objective of this study was primarily directed toward the gathering of information on the condition and development of the Shenandoah River's fish populations, and in evaluation of the effects of the "year-round fishing" permitted in one section. Analysis of the data provided no significant differences between the three areas surveyed. Desirable fish species have satisfactorily recovered from the pollution of the 1940's and the populations are well developed. Excellent growth rates are enjoyed by the principle fish species of the river. The majority of smallmouth bass (76 percent) reach legal size during their third summer of life (age-II+) and the yellow belly sunfish average about 6.4 inches in the same age class.

In West Virginia, the Shenandoah River has a high carrying capacity and is capable of supporting heavy fishing pressures. There is no evidence to indicate that the year-round fishing has adversely influenced or proved detrimental to the river's sport fishery. Conversely, year-round fishing permits the anglers to fully enjoy his sport and better harvest the fisheries surplus.

It is recommended that the 6-mile section from the Millville Dam to the Shannondale Ferry remain open to year-round fishing, with an additional recommendation that the upstream area (3.5 miles) to the Virginia-West Virginia border also be included in this category.

299. Hooper, Paul L. 1954. SPORT FISHING CONDITIONS OF ELK RIVER. A multilith rpt. by the Div. of Fish Mgt., W. Va. Conservation Commission, 17 pp.

The Elk River study has provided sufficient information for sound fish management recommendations.

Elk River is good warm-water fish habitat. Basic ecological requirements, including spawning areas, food and cover are well distributed so as to maintain good fish populations throughout the river. Severe fluctuations in water level and heavy silt loads, however, present limiting factors to the fish carrying capacity of the stream.

No indications were found that the smallmouth bass populations are declining or in any way being depleted by excess fishing pressure. Excellent reproduction was observed annually and scale reading data show good growth conditions. Over 36 percent of the smallmouth bass reach legal size (9.0 inches) during their third summer of life.

There is no evidence that the present concentrations of domestic and industrial pollution are seriously affecting fish life above Clendenin.

Non-game fish, chiefly suckers, comprise a major portion of the fish life in Elk River. Data on the total population of a pool at Hyer, West Virginia, disclosed the following percentages (by weight): smallmouth and spotted black bass, 9.9 percent; walleyes, 7.1 percent; sunfish and rock bass, 9.9 percent; catfish, 8.5 percent; suckers, 59.2 percent; forage fish, 4.4 percent.

In general, Elk River is a smallmouth bass and spotted black bass stream and management should be directed towards the benefit of these two species. Due to the need of a long range program, no immediate physical improvements are proposed for the river at this time.

The Elk River has a watershed 1,550 square miles which has been partially deteriorated by poor forestry, agricultural and mining practices. Through this deterioration limiting factors have been placed on the carrying capacity of the river and only through extensive efforts in educational training, state assistance and cooperation of the land owners and interested public can the eventual recovery of this watershed be realized.

No population control is recommended at this time except through management of fishery practices and regulations. No smallmouth bass or other warm-water fish stockings are recommended. The present number of bass existing in the river, accompanied by the good spawning conditions for these species make such stockings useless.

300. Nielsen, C. S. 1954. THE MULTITRICHOMATE OSCILLATORIACEAE OF FLORIDA. Qtrly. Journ. Fla. Acad. Sci., Vol. 17, Nos. 1 and 2, March and June, pp. 25-42 and 88-104.

These two articles present keys to genera and species of the blue-green algae found in the State of Florida together with descriptions of each species.

301. Johnson, Malcolm C. 1954. A SUGGESTED INORGANIC FERTILIZER FOR USE IN BRACKISH WATER. Qtrly. Jrnl. of the Fla. Acad. Sci., Vol. 17, No. 2, June, pp. 119-127.

At Marineland in Florida the initial pond culture experiment was set up to give information on the carrying capacity, in terms of pounds of fish, of unfertilized esturine waters and the increase in production due to fertilization. It was therefore necessary to determine a mixture of inorganic fertilizer that contained the major limiting plant nutrients in a ratio that would give satisfactory results when applied to salt or brackish water. The purpose of the particular study reported here was to obtain an estimate of the efficiency of the formula devised.

Potassium is present in excess in sea water and was not considered a limiting factor in plankton production.

Nitrate nitrogen and phosphate phosphorus are present in sea water in the constant ratio 16:1 by atoms, or approximately 7:1 by weight. These materials are absorbed and released by marine plankton algae in the same ratio (Sverdrup, Johnson

and Fleming, 1942). It seemed reasonable to assume that a satisfactory fertilizer for salt water would be one that delivered these nutrients in solution in the 7:1 ratio.

Because the analysis of commercial inorganic fertilizer is expressed as percent elemental nitrogen, phosphoric acid, and potash, it was necessary to convert the 7:1 nitrate:phosphate ratio to the N:P_2O_5 desired in solution. Then since Pratt (1949) had shown that a loss of 2/3 of the added phosphorus might be expected, the relative P_2O_5 proportion was tripled, resulting in a 1.6:2.3 ratio, or approximately a 6-9-0 (1.6:2.3x4) analysis fertilizer. A commercial 7-9-0 fertilizer which was available in the Marineland area was adopted instead.

Four 1/8-acre rectangular ponds were excavated in alluvial mud soil typical of the tidal marsh areas of the Southeast Atlantic States. The above-water portion of the dikes was composed of an admixture of mud, sand, and oyster shells, and was sufficiently high to prevent topping by flood waters. A 12-inch inlet pipe was installed through one dike in each pond. The pipes in three of the ponds were fitted with automatic storm-gate valves that allowed water from the Intracoastal Waterway to enter the ponds whenever the pond water level fell below that of flood tide. The valves prevented the efflux of water during ebb tides. On the other pond the pipe was fitted with a standpipe that permitted the inflow and outflow of tidal water whenever flood tide exceeded the height of the standpipe. Each pond had an average depth of 3.5 feet.

The mud in which the ponds were dug was extremely impervious to water.

Each pond was stocked with 2,000 fingerling mullet per acre on December 31, 1952. Ponds 1 and 3 were fertilized, ponds 2 and 4 unfertilized during 1953.

Applications of the 7-9-0 fertilizer were made at the rate of 200 pounds per acre per month, which is equal to 14 pounds of elemental nitrogen and 18 pounds of P_2O_5. On the basis of the calculated pond volume, the potential increase in dissolved N was approximately 1.48 ppm and in P_2O_5 approximately 1.69 ppm at each application. Actually, these materials do not go into solution immediately but gradually over a period of hours or days, and are utilized in whole or part by algae as they dissolve.

Although fertilization was begun January 12, 1953, the first nutrient analysis was not made until May 19, 1953. Beginning on that date, estimates were made for dissolved phosphorus and nitrogen in both the fertilized and unfertilized ponds between each application of fertilizer.

In the fertilized ponds (1 and 3) phosphorus was present at least in trace quantities in four of the six determinations.

Pond 2, though unfertilized, was not a good unfertilized control. It lay between two fertilized ponds and it is believed that due to a lower surface level a relatively high rate of seepage from the bordering fertilized ponds took place.

Pond 4 did not produce a visible plankton bloom, but had much the same appearance throughout the year as the surrounding natural water.

From the data gathered it seemed that dissolved phosphorus was, in general, present in the fertilized waters in quantities greater than those necessary to maintain the desired N:P_2O_5 ratio.

The best fertilized ponds produced 276.8 pounds of mullet per acre, an increase of 122.4 pounds or 79.3 percent over unfertilized water.

302. Moody, Harold L. 1954. ADULT FISH POPULATIONS BY HAUL SEINE IN SEVEN FLORIDA LAKES. Qart. Jour. Fla. Acad. Sci., Vol. 17, No. 3, September, pp. 147-167.

Fish population studies were made in Lakes Ashby, Harney, Monroe, Jessup, Panasoffkee, Johns Lake, and Black Lake by means of a rough fish removal unit employing a haul seine of about 800 yards in length, deep enough to fish the bottom, and with a minimum mesh size of three inches, stretched measure. The minimum average water depth in which the net was used was about three feet, and the maximum twelve. The mesh size permitted no fishes smaller than those of the size of bluegills of 4.5 inches in total length to be taken.

Harney and Monroe in the St. Johns River chain yielded low fish populations. Gizzard shad made up the bulk of the catch in both lakes. Lake Ashby also yielded low populations; channel catfish and shellcracker were the more abundant species. Lake Jessup, connected with the St. Johns River, was found to have high populations, but about 50 percent of the catch was gizzard shad, and about 27 percent catfishes. Lake Panasoffkee hauls revealed high fish populations, but about 70 percent of the catch was composed of rough fishes, principally gizzard shad and garfishes. Despite this fact the average sizes of the individuals of numerous species, particularly the shellcracker, were larger than those found in the other lakes. The hard shelled cooter, Pseudemys, was taken in very large numbers. The fish populations in Johns Lake were dominated by the channel catfish and the gizzard shad. Baiting a haul area for catfishes was practiced with considerable success. A check on the effectiveness of the rough fish removal here was made possible by a re-entry two and one-half months later. The catch of rough fish was found reduced by one-half. In Black Lake more than 77 percent of the total weight of the populations taken consisted of garfishes, and about one percent of gamefishes.

303. Caldwell, David K. 1954. ADDITIONS TO THE KNOWN FISH FAUNA IN THE VICINITY OF CEDAR KEY, FLORIDA. Qtrly. Jrnl. of the Fla. Acad. Sci., Vol. 17, No. 3, Sept., pp. 182-184.

Nine species are listed, seven of which are apparently new to the known fish fauna of the area, an eighth is confirmed, and a ninth previously unreported for some 70 years.

304. Cole, Gerald A. 1954. STUDIES ON A KENTUCKY KNOBS LAKE. (I. Some Environmental Factors). Trans. of the Ky. Acad. of Sci., Vol. 15, No. 3, Oct., pp. 31-47.

Tom Wallace Lake is a small, artificial body of water in the Jefferson County Forest about 10 miles

south of Louisville, Kentucky. Although there has been no rigid program of investigation of the lake, many data have been obtained, and a series of studies has been planned for the future. The immediate purpose of this paper is to present some limnological data which will serve as a foundation for reports on the flora, fauna, and additional physico-chemical phenomena of Tom Wallace Lake.

The lake is a semi-drainage artificial lake situated among typical steep wooded knobs. It occupies a precipitous basin, narrow and U-shaped in sections. The surface area is 2.34 ha., and the maximum depth is 9 m. The mean depth is 4.1 m., and the wind-effective dimensions are small.

The littoral zone, extending to a depth of 2 m., is 26.1 percent of the total bottom area. The sublittoral is 31.5 percent and the profundal zone is 42.4 percent of the bottom. Profundal sediments are varved and composed of alternating strata of clay and sapropelic material.

Direct thermal stratification is continuous from the latter part of March until early November. The winters are usually periods of continuous circulation with isothermal conditions at about 4° C., although ice covers of short duration sometimes occur with a resulting inverse stratification. Bottom waters are warmest at the overturn, reaching 10° C. then. High thermoclines, low hypolimnion temperatures, and unusual thermal gradients which often occur may be ascribed to the sheltered location of the basin.

Transparencies as measured by Secchi disc are greatest at the overturn. The mean annual transparency is about 1.7 m.

During summer stagnation an eutrophic oxygen curve exists with complete absence of dissolved oxygen in the lower part of the hypolimnion for about 5 1/2 months. Highest oxygen tensions occur in the summer epilimnion, and sometimes in the thermocline.

Waters below 5 m. are usually slightly acid, reaching a pH of 6.4 at 8 m. by the end of stagnation. Free CO_2 is always present at a depth of 4m. and below, and is lacking in the epilimnion only during the summer. A concentration of 112.4 p.p.m. was accumulated by the end of one summer in 8 m. water.

Carbonates occur only in the epilimnion, and only during the summer. Bicarbonates are lost from the lake via flushing during rainy winters, and the loss each winter is correlated directly with the amount of precipitation. There seems to have been an increase in total alkalinity during the past four years, and the lake is changing from a soft water lake to a medium hard water lake.

The fitness of the lake as an ideal bass habitat is questionable in spite of its definite eutrophy.

305. Carter, Bernard T. 1954. THE MOVEMENT OF FISHES THROUGH NAVIGATION LOCK CHAMBERS IN THE KENTUCKY RIVER. Trans. of the Ky. Acad. of Sci., Vol. 15, No. 3, Oct., pp. 48-56.

A total of 10 of the 14 existing locks on the Kentucky River were used as test areas in an effort to determine if and to what extent the fishes of this river used the navigation locks as a means of travel from one pool to the other.

A total of 29 species of fish were found to be using the locks. In the 10 locks 2,821 fish, weighing 864.27 pounds, were found to have moved into the lock chambers from the pools below the dams and all except 449 of these fish, weighing 84.56 pounds, were assumed to have moved out of these chambers upstream into the pools above.

What effects this movement has on the fish populations of each individual pool is not known, nor is it known what this movement contributes to the fishery of the entire river system. Some of the possible effects have been discussed.

306. Bennett, George W. 1954. LARGEMOUTH BASS IN RIDGE LAKE, COLES COUNTY, ILLINOIS. Bulletin of the Ill. Natural History Survey, Vol. 26, Article 2, Nov., 59 pp.

Ridge Lake is an artificial impoundment that at overflow level in 1941 had an area of 18.1 acres and a maximum depth of 25 feet. It was made by damming Dry Run Creek, a tributary of the Embarrass River, in Coles County, Illinois. Both tower and surface spillways were constructed. Silting of the lake basin was and is a serious problem. The lake is eutrophic-like in character in that it has no dissolved oxygen in the deep water in summer, except when the cool oxygen deficient water is flushed out of the lake through a tower spillway by the entrance of surface runoff into the lake basin after heavy rains.

The lake was stocked in 1941 with 435 bass, in 1944 with 129 bluegills, and in 1949 with 138 warmouths. In 1942, and most subsequent years, the public was allowed to fish from boats belonging to the Natural History Survey, and a record was made of kinds, numbers and weights of all fish caught; time spent in fishing, kinds of baits, and the tackle used. A few scales were taken from each of the bass caught and from most of the larger bluegills for age analyses.

At intervals of 2 years, beginning in 1943, the lake was drained in early spring and a census was made of the fish. After each census, the large bass were marked by fin-clipping and returned to the partially refilled lake basin.

No stocks of fish, other than those previously mentioned, were introduced into Ridge Lake from other bodies of water. During the study period from the spring of 1941 to after the bass spawning season in 1951, more than 11,000 bass and 154,000 bluegills were permanently removed from the lake by angling and in draining censuses. About 3,500 fish other than bass, bluegills, and warmouths were taken from the lake during the study period. These, which included green sunfish, black bullheads, yellow bullheads, carp, and a black buffalo were of species indigenous to Dry Run Creek and the Embarrass River. Although large numbers of bass and bluegills were removed from Ridge Lake, these fish were as numerous in the Lake in 1951 as they had been at any other time during the 10-year study period.

The weight of bass taken in the five draining cen-

suses ranged from 31.5 pounds per acre in the 1947 census to 50.4 pounds per acre in the 1949 census. Poundage calculations suggest that the carrying capacity of Ridge Lake for bass may be about 50 pounds per acre. Once the bluegill population had become well established in the Lake, poundages per acre varied between 86.9 and 193.3; the largest poundage of bass was found with the smallest poundage of bluegills (1949 census) and the largest poundage of bluegills with the smallest poundage of bass, suggesting interspecific competition.

Yields of bass taken by angling during years in which the lake was open to public fishing varied between 10.9 and 30.0 pounds per acre; yields of bluegills varied between 6.2 and 45.9 pounds per acre. Fishing pressure ranged from 90 man-hours per acre in 1944 to 320 man-hours per acre in 1948.

There was no apparent relationship between the number of bass of spawning age in the lake in any given season and the number of bass fry produced in that season. Years in which small fish were abundant in the lake (particularly those years in which many small bluegills were present) were years of low production of bass fry.

The ratios of numbers of bass fry of a brood to individuals of the same brood taken as larger fish in the 21 months after spawning varied between 29 to 1 and 40 to 1, in 1941, 1943, 1947, and 1949. In 1945, when the number of bass fry produced was unusually large, the survival ratio was 195 to 1.

Bass at Ridge Lake averaged 8.1 inches total length at 1 year of age, 10.3 inches at 2 years, 12.6 inches at 3 years, and 13.7 at 4 years. Bluegills averaged 4.7 inches total length at 1 year of age, 6.2 inches at 2 years, and 7.1 inches at 3 years.

Some of the factors influencing the yield of bass in any given fishing season were the number and weight of bass available, the fishing pressure, and the amount of natural food available for bass. While all of these factors undoubtedly were important in determining the bass yield the highest catches, in terms of number and weight of bass available, were made in years when small fishes and other bass foods were reduced through lake draining prior to the fishing season.

In the 2-year period preceding the first draining census and in each of four 2-year periods between draining censuses, numbers of bass that had been marked by fin-clipping disappeared from Ridge Lake. The unaccountable losses among the bass with which the lake was originally stocked amounted to 86.7 percent in the 1941-1943 period; the losses were so high as to suggest that many of these fish died from injuries received in transportation or handling. Among the bass produced in the lake and later marked, unaccountable losses were lower in the middle age groups than in older and younger age groups. As the fish approached the age of 10 years, the losses increased, suggesting that the fish were approaching the end of their normal life span.

For their contingent travel, meals, tackle, and licenses, fishermen at Ridge Lake in 1949 are estimated to have spent an average of $1.22 for each hour of bass fishing. Because they averaged 7.1 hours in catching 1 pound of bass, the calculated cost of their catch was $8.66 per pound.

307. Morgan, Alfred R. and F. C. Cleaver. 1954. THE 1951 ALSEA RIVER CHINOOK SALMON INVESTIGATION. Oreg. Fish Commission Res. Briefs, Vol. 5, No. 1, March, pp. 15-26.

During the fall of 1951, a tagging program was conducted on the Alsea River by the Fish Commission of Oregon in order to gain information on the fall run of chinook salmon.

Before the commercial season opened in September, 129 fall chinook salmon were tagged with Petersen-type plastic tags. Following the opening of the commercial season, 27 additional chinooks were tagged.

Tags were recovered in the commercial fishery. It was calculated that approximately 70 tags and tag scars were included among the 2,197 fish taken in the commercial fishery.

Only five tags were recovered in spawning ground surveys.

It was calculated from tag recoveries that the fall-run chinook salmon population available to the commercial fishery in the Alsea River in 1951 was slightly more than 5,000 fish. The upper and lower 95 percent confidence limits were calculated from recoveries in samples of the commercial catch and were found to be approximately 6,500 and 3,600 fish, respectively.

A fishing mortality of 44 percent was found in the portion of the population available to the commercial fishery. This mortality is considerably greater than the 15 percent fishing mortality found for Alsea River silver salmon (Morgan and Cleaver, in press). The bulk of the chinooks were taken during the first week in September.

The length of time which elapsed between the time of tagging and the time of recovery in the commercial fishery ranged from 2 to 23 days. By September 8, 91 percent of the recoveries of fish tagged in August had been made.

Fish which were recovered on the spawning grounds, alive and spawned out, had been tagged from 52 to 63 days.

The few recoveries made on the spawning grounds were made in widely separated areas of the Alsea drainage.

308. Morgan, Alfred R. and F. C. Cleaver. 1954. THE 1951 ALSEA RIVER SILVER SALMON TAGGING PROGRAM. Fish Commission of Oregon, Contribution No. 21, June, 30 pp.

During a tagging operation conducted in 1951 on the Alsea River, 1,142 adult silver salmon were tagged with plastic Petersen-type tags and stainless steel jaw tags.

The number of fish taken in the commercial catch each week was calculated by dividing the number of pounds in the weekly catch by the average weight of the fish in the samples for that week. It was calculated that the commercial fishery took approximately 14,000 fish during the season, which was only about 15 percent of the run available to the fishery.

The number of tags taken each week by the com-

mercial fishery was calculated by dividing the number of fish in the catch each week by the number of fish per tag in the samples for the week. It was calculated that 67 tags were taken during the season by the commercial fishery. This number of recoveries was 15.5 percent of the 438 tags available to the fishery.

With the cooperation of a number of boat moorages on the Alsea River, an estimate of the sport catch of silver salmon was made. It was calculated that the lower river sport fishery took approximately 3,000 adult silvers with an additional 500 fish being taken by the bank fishery. The weight of the total catch of 3,500 fish was calculated to be about 33,000 pounds. This weight formed 20.2 percent of the combined commercial and sport catches. It was calculated that 18 tagged fish were taken in the sport catch.

A total of 44 numbered Petersen and jaw tags were recovered from both dead and live fish which had reached spawning areas. This number includes three tags recovered from the spawning grounds of adjacent streams.

After the fish moved beyond the fishing area, many still did not move rapidly to the spawning grounds. Several were taken in tidewater or in the vicinity of tidewater 48-58 days after they had been tagged.

The average time between tagging and recovery on the spawning grounds was 63 days for live fish and 70 days for dead fish.

Using the method proposed by Schaefer (1951a) for obtaining a population estimate from spawning ground recoveries, an estimate of the population available to the fishery was made from the number of tags recovered by sampling the commercial catch. It was calculated that approximately 90,000 fish were available to the fishery.

Approximately 63,000 of the fish available to the commercial fishery continued the migration to the spawning grounds.

Spawning ground tag recoveries provided an estimate of the population in the lower river which was in close agreement with the estimate of the population made from tag recoveries in the commercial fishery.

309. Webster, Dwight A. 1954. SMALLMOUTH BASS, MICROPTERUS DOLOMIEU, IN CAYUGA LAKE (Part 1. Life History and Environment). Agricultural Experiment Station, Cornell University, Memoir 327, May, 39 pp.

Two populations of smallmouth bass that frequent the west shore of Cayuga Lake are discrete, in that one is a spawning population (Taughannock Creek) and the other a winter aggregation (Flat Rock). Although the two populations are separated by only a mile and a half of shoreline, recovery of bass tagged in the two areas indicates that they are also largely independent as individuals. Taughannock fish are locally distributed, while Flat Rock bass show a pronounced tendency to disperse to the northern portions of the lake.

The absence of extensive gravel shoals and the predominance of deep water are probably important factors controlling the abundance of smallmouth bass in Cayuga Lake. They do descend to depths of 50 to 60 feet, however, and this habit may limit their availability in many areas of the lake. As the principal food of bass is the alewife, the verticle distribution of the food species may in part determine bass distribution. Alewives characteristically move offshore after spawning in early summer.

Bass fare well on this diet, judging from the growth rate of Flat Rock fishes that reach 10.3 inches at the end of the fourth growing season (age III+), 13.7 inches at V+, and 15.6 inches at VII+. These fish are well conditioned and at the above lengths average 9, 25, and 37 ounces in weight. Male bass usually mature at ages III and IV, females one year later. There is no differential in growth between the sexes, but there is a marked difference in the growth of juvenile and adult bass of the same age.

Spawning takes place in the major tributaries and the northern shoals of the lake in late May and June. In the main body of the lake, spawning is retarded and extends well into July. Of 161 nests observed in Taughannock Creek during 1945-47, 20 to 30 percent failed to produce black fry, largely because of heavy fungus infestation.

310. Brown, C. J. D. and Stanley G. Jewett, Jr. 1954. SOME LIMNOLOGICAL AND FISHERIES OBSERVATIONS ON COTTAGE GROVE RESERVOIR (Coast Fork, Willamette River, Oregon). Proceedings of the Montana Academy of Sciences, Vol. 14, pp. 31-43.

This paper presents physical, chemical and a small amount of biological data on Cottage Grove Reservoir, a flood control reservoir on the Coast Fork of the Willamette River in Oregon. At capacity the reservoir has a surface area of 32,982 acres, while at low level it has an area of 3,000 acres. Information is given on temperature, oxygen, carbon dioxide, pH, alkalinity and water transparency for the period April 30, 1946, through October 9, 1946. Only very general observations were made on plankton and bottom fauna. Fishing with nets in August produced only rough species.

311. Buzzell, R. D. and E. T. Walker. 1954. A STUDY OF SPORT FISHING IN TIDEWATER MARYLAND. Md. Dept. of Research and Education, Resource Study Report No. 4, March, 20 pp.

Two separate papers are included in this report, each of which deals with a different aspect of the sport fishing industry.

The first study, an economic study of the Maryland Tidewater sport fishery, conducted during the summer of 1953, was sponsored cooperatively by the Sport Fishing Institute and the Maryland Department of Research and Education, and deals with the expenditures of the sport fisherman, and the "associated" values of the industry to the State's economy.

The second portion, an intensive survey of the Patuxent River sport fishery, presents the results of an intensive survey conducted during 1952 on the

Patuxent River between Solomons and Benedict, Maryland. This area, approximately 21 miles in length, is heavily fished by sportsmen, and is particularly representative of the outboard and small inboard boat fishing of tidewater Maryland.

312. Hashimoto, Shoichi. 1954. CHEMICAL FERTILIZATION OF MULLET PONDS. Proc. of the Hawaiian Ac. of Sci., 29th Annl. Meeting, p. 14.

The use of chemical fertilizers to increase the production of fish in fresh-water ponds is a common practice on the mainland. Many investigations have been conducted on fertilizer treatment in fresh-water ponds, but there is a dearth of corresponding information on sea-water ponds.

The chief food of mullet is plankton, which is a community of free-floating animal and plant life. The plant form of plankton provides the basic food supply of marine life and, like the plant on land, manufactures carbohydrates and proteins by photosynthesis, giving off oxygen as a by-product. Similar to vegetation on land, the plant form of plankton responds in growth and development to availability of the three primary plant nutrients; namely, nitrogen, phosphoric acid, and potash.

Three years of commercial fertilizer application to a mullet pond on windward Oahu has been made to correct a problem in nutritional deficiency of plankton life. A change in conditions of the pond's watershed during the past 10 years had caused a depletion of mineral nutrients required for development of the plant form of plankton in the pond. This had resulted in a decrease of food and oxygen supply for the mullets. The growth of the fish was retarded, and their edible qualities deteriorated. During summer months, toxic sulphide gas was formed and many fish died. The use of chemical fertilizer in the pond eliminated these troubles.

A method for estimating the amount of chemical nutrients required in a mullet pond is given, using a rich sea water as the criterion.

Not all mullet ponds in Hawaii lend themselves to chemical fertilizer treatment. They must have several essential conditions, such as clear water, a good gate and sea wall, not excessive depth, ample sunlight, and provision for adding fresh water to compensate for evaporation loss during the dry summer months. Where satisfactory conditions are present, however, this technique of chemical fertilization promises to correct serious nutritional deficiencies and help save the Hawaiian pond mullet industry. (A)

313. Bick, George H. 1954. A BIBLIOGRAPHY OF THE ZOOLOGY OF LOUISIANA. Proc. of the La. Acad. of Sci., Vol. 17, October, pp. 5-48.

The citations on which this paper is based have accumulated over a period of approximately 18 years. The bibliography is focused primarily on Taxonomy and Natural History. The subjects covered are (1) Climate, geology, physiography; (2) wildlife management, economic aspects; (3) limnology; (4) brackish waters and faunal lists.

314. Darnell, Rezneat M. 1954. AN OUTLINE FOR THE STUDY OF ESTUARINE ECOLOGY. Proc. of the La. Acad. of Sci., Vol. 17, October, pp. 52-59.

The Department of Zoology of Tulane University and the Commercial Seafood Division of the Louisiana Wild Life and Fisheries Commission have begun a cooperative investigation of basic ecology of Lake Ponchartrain. This paper presents an outline of the study under major headings such as Personnel, Major Field Equipment, Methods, Problems, and Aims.

The aims of this study of estuarine ecology are:
1. By ascertaining the distributions, movements, and potentialities of each species, the study would attempt to inventory stocks of an important natural resource.
2. By analyzing population levels and fluctuations in numbers, the study would seek to determine methods of operation of the controlling factors. This would aid in insuring continuance of the resource even under increasing catch pressure by man.
3. By relating estuarine events to those occurring in marine waters, the study would permit greater understanding of the inter-relationships between brackish water and marine ecology.

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